ATP 4-14

Expeditionary Railway Center Operations

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Expeditionary Railway Center Operations

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Preface

ATP 4-14 provides doctrine for rail operations in support of unified land operations. It describes the organizations, processes, procedures, and systems involved in rail operations across the range of military operations. This Army techniques publication (ATP) is written to explain the functions of expeditionary railway center service in a theater of operations. It provides basic information for commanders and staffs of supporting units and for staff officers of higher headquarters to aid the utilization of rail and the expeditionary railway center. ATP 4-14 provides guidance to our joint and multinational partners about the contributions of Army rail to sustainment in joint and multinational operations. This publication augments the sustainment principles, tactics, and procedures discussed in ADP 4-0 and FM 4-0.

The principal audience for ATP 4-14 is all members of the profession of arms. Commanders and staffs of Army headquarters serving as joint task force or multinational headquarters should also refer to applicable joint or multinational doctrine concerning the range of military operations and joint or multinational forces. Trainers and educators throughout the Army will also use this publication.

Commanders, staffs, and subordinates must ensure that their decisions and actions comply with applicable U.S., international, and in some cases host-nation laws and regulations. Commanders at all levels will ensure that their Soldiers operate in accordance with the law of armed conflict (LOAC) and applicable rules of engagement (see FM 6-27/MCTP 11-10C).

ATP 4-14 uses joint terms where applicable. Selected joint and Army terms and definitions appear in both the glossary and the text. Terms for which ATP 4-14 is the proponent publication (the authority) are italicized in the text and marked with an asterisk (*) in the glossary. Terms and definitions for which ATP 4-14 is the proponent publication are boldfaced in the text. For other definitions shown in the text, the term is italicized and the number of the proponent publication follows the definition.

ATP 4-14 applies to the Active Army, Army National Guard/Army National Guard of the Unites States and Unites States Army Reserve unless otherwise stated.

The proponent of ATP 4-14 is the United States Army Combined Arms Support Command. The preparing agency is the G-3/5/7 Doctrine Division, United States Army Combined Arms Support Command. Send comments and recommendations on a Department of the Army (DA) Form 2028 (*Recommended Changes to Publications and Blank Forms*) to Commander, United States Army Combined Arms Support Command, ATTN: ATCL-TDD (ATP 4-14), 2221 Adams Ave, Building 5020, Fort Lee, VA 23801-1809 or submit an electronic DA Form 2028 by e-mail to usarmy.lee.tradoc.mbx.leee-cascom-doctrine@army.mil.

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Introduction

From the introduction of rail as a mode of transport to modern day military operations, rail has proven itself to be a significant combat multiplier. The successful use of a railway system can dramatically reduce the logistical footprint and be a source of cost savings. Even a small train can move as much as a single Army truck company, while simultaneously mitigating great risk to Soldiers' lives by keeping drivers off dangerous roads.

The Army's rail force that transitioned to the expeditionary railway center, comprised of four rail companies and one rail battalion, reflected a traditional operating unit and was not consistent with current operational needs. The logistical operational environment had changed from the physical operation of rail to the management of rail. Functional analysis identified existing rail infrastructure assessment, effective rail planning, and advising and assisting host-nation (HN) rail personnel and organizations as critical requirements to a combatant commander.

To meet current and future war time demands, the rail force structure transformed into the expeditionary railway center, the only remaining rail organization in the Army. It is comprised of a headquarters and five separate, deployable railway planning and advisory teams. It is capable of conducting rail network capability and infrastructure assessments, rail safety assessments, and using these assessments to inform and advise the combatant commander on the employment of rail in a theater of operations. Additionally, the expeditionary railway center is capable of partnering with host-nation rail and advising and assisting in the effective management of its railway system. This organizational structure was validated with the Afghan rail advisory team during Operation Enduring Freedom.

ATP 4-14 contains significant revisions since the last publication. Changes include updates to the expeditionary railway center's structure, roles, and relationships in theater, unit planning considerations for conducting rail operations, and adds an annex for conducting rail load operations as part of the operations process. This manual also incorporates historical operational information that United States (U.S.) Army rail personnel used in the past. This information is included to provide methods and procedures to use as a baseline during an advise and assist mission in the event that a HN's systems are found to be lacking or inadequate in any way, or as reference material when conducting training with HN organizations.

ATP 4-14 contains 7 chapters and 9 appendices.

Chapter 1 describes the roles and missions of the expeditionary railway center, the structure of the expeditionary railway center, and how the expeditionary railway center and its teams and personnel can be used in a theater of operations.

Chapter 2 provides a baseline of knowledge on rail operations, methods of rail operations, rail facilities, and rail communication.

Chapter 3 provides detailed formulas and calculations required to conduct rail planning.

Chapter 4 discusses a railway's physical components, structure and construction. It is designed to give expeditionary railway center personnel information they will require when conducting a railway reconnaissance for a theater infrastructure assessment.

Chapter 5 introduces different types of equipment that are found on both American and foreign railroads. It also discusses potential issues and mitigation techniques when using foreign equipment. It is designed to give expeditionary railway center personnel information they will require when conducting a railway equipment reconnaissance as part of a theater assessment.

Chapter 6 discusses battlefield and shipment security in a theater of operations.

Chapter 7 covers safety considerations, references to safety rules used by American personnel on American railways, and accident reporting.

Appendix A lists the various records and reports that were utilized by U.S. Army rail companies of the past.

Appendix B gives a full example, including mathematical calculations, of the planning of a rail operation in theater.

Appendix C details processes to plan, prepare, execute, and assess rail load operations.

Appendix D explains the dispatching operations and procedures used by U.S. Army rail organizations.

Appendix E explains the main line operations procedures used by U.S. Army rail organizations of the past.

Appendix F explains the yard and terminal operations and procedures used by U.S. Army rail organizations of the past.

Appendix G explains the different types of rail accidents that can occur, how to react to these accidents, and how to recover rail equipment after it has been involved in an accident.

Appendix H provides planning factors for man-hour requirements for the construction and rehabilitation of rail track.

Appendix I provides rail assessment teams with techniques and considerations for conducting rail assessments. It provides sample formats for railway data collection.

Introductory table-1. Modified Army terms

Term	*Remarks*
continental system	rescinds term
wythe system	rescinds term

Chapter 1
The Expeditionary Railway Center

Historically, the Army rail force structure was focused on providing a rail operating capability. The changing, modern operational environment required expertise on the management of rail operations. As a result, during Operation Enduring Freedom, Reserve component rail units and experts adapted to form the Afghan Rail Advisory Team (RAT), which provided a planning, advising, and assisting capability to meet the combatant commander's requirements. This further resulted in the reorganization of rail units (four companies and one battalion) into the expeditionary railway center (ERC) with a single headquarters and five deployable railway planning and advisory teams (RPAT), consisting of three rail advisory teams each.

ROLE OF THE EXPEDITIONARY RAILWAY CENTER

1-1. Successful employment of rail is contingent upon commanders and staff understanding rail's potential capabilities. The ERC provides this understanding. The ERC is a force structure within the Reserve component that consists of Army rail experts that perform six key functions:

- Provide rail network capability and infrastructure assessments.
- Perform rail mode feasibility studies and advise on employment of rail capabilities.
- Coordinate rail and bridge safety assessments.
- Perform and assist with rail planning.
- Coordinate use of host-nation (HN) or contracted rail assets.
- Perform contracting officer's representative duties to oversee contracts and provide quality assurance of the contracts.

1-2. Army rail has shifted to a planning, advisory, capability assessment, and coordinating centric force, and has foregone the old strategy of providing operating control over HN rail capability. The focus of the ERC is planning and coordinating rail operations within a theater of operations. The ERC can also focus on enhancing strategic and operational throughput, such as port clearance via rail, and provide contracting officer's representative oversight. The ERC will provide the required rail expertise to accomplish all of this to the combatant commander and theater sustainment command (TSC) or expeditionary sustainment command (ESC) commander, their subordinate sustainment brigades, and the HN. The modular nature of the organization and its ability to plug into multiple levels of command across the range of operations will enhance this capability.

STRUCTURE OF THE EXPEDITIONARY RAILWAY CENTER

1-3. The ERC is a modular force consisting of a single headquarters element and five deployable RPATs each consisting of three RATs. Each RAT is further subdivided into two rail advisory crews (RACs) led by an E-6. Total manpower of the unit is authorized at 181 Soldiers. The headquarters element consists of 11 Soldiers, including the ERC's O-6 commander. The railway planning and advisory teams each consist of 34 Soldiers, including their O-5 rail chiefs. See figure 1-1 on page 1-2 for ERC structure and command relationships.

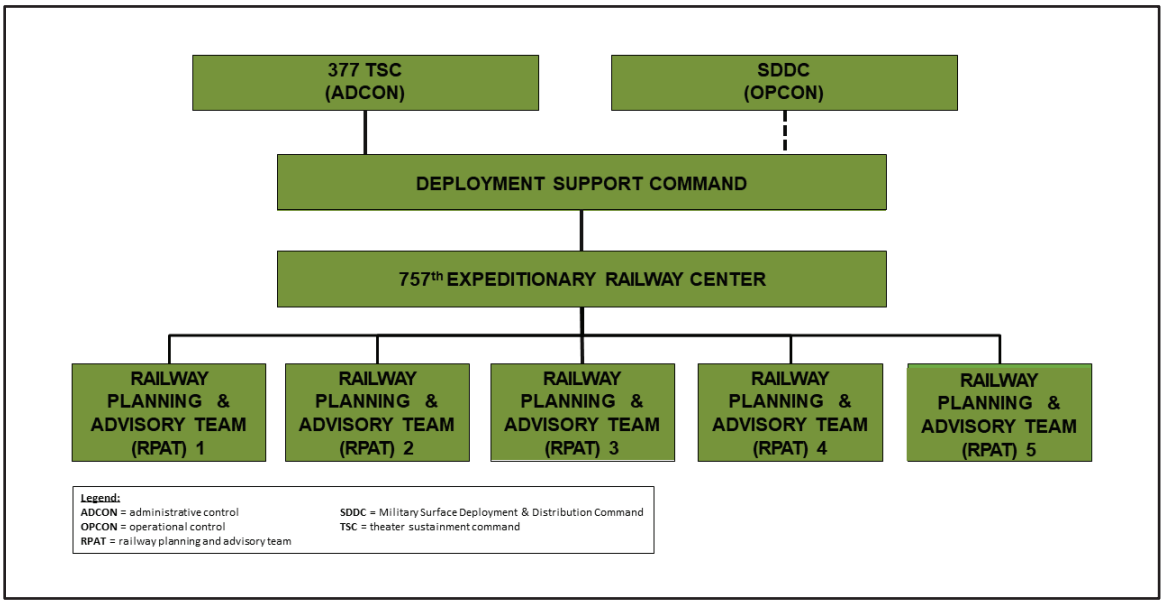


Figure 1-1. Expeditionary Railway Center structure and command relationships

1-4. The headquarters element provides command and control for subordinate RPATs. It functions as the primary advisor to Military Surface Deployment and Distribution Command (commonly known as SDDC) joint force land component commander, or Army Service component commander on railway operations (common operating picture) and strategic planning to include interface and collaboration with HN rail officials for the support of military strategic and operational requirements. It also provides an engineer officer to facilitate rail assessment capability and rebuild efforts.

1-5. RPATs provide direct assistance to the HN by directing or delegating its three RATs. It also functions as the primary advisor on railway operations to a corps or TSC. They perform the functions of advisement related to HN rail infrastructure and employment of HN assets in support of military operations. They coordinate and communicate with the HN, supported unit, or contracted entity to facilitate rail operations. They perform contracting officer's representative functions and conduct planning in support of the sustainment brigade, ESC, and TSC. See figure 1-2 for RPAT structure.

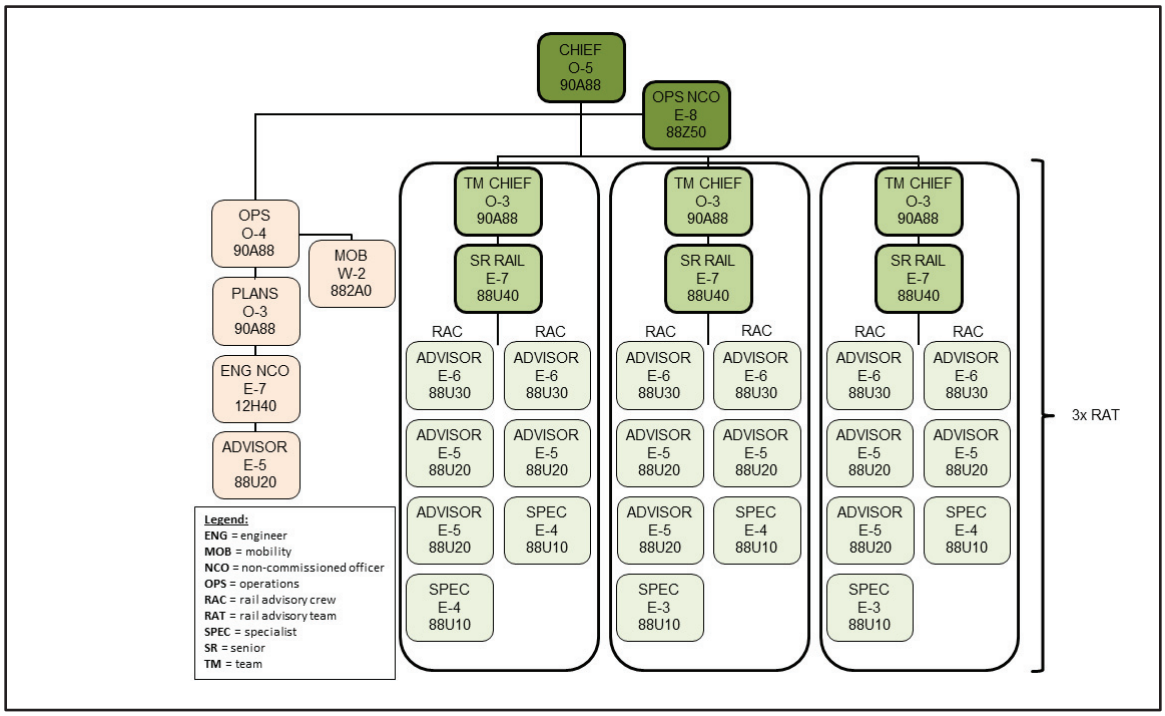


Figure 1-2. Railway Planning and Advisory Team structure

1-6. The ERC does not retain any operational rail equipment.

OPERATIONAL CONCEPT

1-7. Combatant commanders address the employment of the ERC or RPATs in their operation plans and time-phased force and deployment data to ensure requirements are satisfied. To make the decision, the commander may take several factors and planning considerations into advisement, such as the following:

- Size and scope of the HN rail infrastructure in place. This provides a guide in determining the amount of ERC personnel that will be required to undertake the mission at hand.
- Number of operating personnel in the HN rail system, including train operating crews, yard crews, and maintenance personnel. This provides a guide to determine the number of ERC personnel that will be required to adequately advise and assist the HN personnel.

1-8. During the initial stages of a military operation in an immature theater, if information and intelligence concerning the railway system is limited, one railway planning and advisory team should deploy to conduct initial reconnaissance and evaluation of the theater. During this process, a follow-on team should be placed on standby to deploy to provide support if deemed necessary by the combatant commander. Regardless of the number of teams deployed to one or more theaters of operation, one team should be maintained on a ready reserve status in case they are needed to fill critical gaps during an operation.

1-9. At home station, the ERC is administratively controlled by the 377th TSC's Deployment Support Command, which is operationally controlled by the Military Surface Deployment and Distribution Command. While deployed, the optimal level of assignment for the ERC is a theater level command, to include a joint task force, TSC, or ESC. ERC personnel are optimally employed as an augmentation to the TSC staff. The ERC commander can place an appropriate number of railway experts at the appropriate headquarters to influence the coordination and planning phase of the current or future operational plan and meet the combatant commander's requirements.

1-10. Based on the mission variables, which include mission, enemy, terrain and weather, time available, troops, and civil considerations, the ERC can place railway specialists at different locations and commands to assist HN railway personnel or officials and to fulfill their advisory roles. Upon arrival in theater, the ERC

may conduct an initial assessment of the railway infrastructure and conduct an inventory of railway assets (rolling stock and locomotives). If the scope of the civil reconnaissance, based on the mission variables, is beyond the capacity of the ERC, it can provide information requirements for maneuver or civil affairs elements for a hasty assessment or coordinate with civil affairs functional specialists for a technical assessment. Based on the scope of the mission, the ERC will determine the technical requirements for reconstruction efforts. If the HN does not have the capability for repair, the ERC will then engage the combatant commander with a recommendation. Based on the nature of the mission and in conjunction with the Department of State, the combatant commander will determine the requirement for rehabilitation or reconstruction projects, which may require contractors to complete. The ERC will coordinate for any contracting of approved projects.

1-11. The ERC will also perform inspections to assess compliance with HN rail track gauge standards. 757th ERC maintains forms and guidance on how to perform these assessments. The ERC will also be employed to inspect all bridges and stations for damages and structural integrity and advise on necessary improvements. The ERC will recommend potential future rail utilization by commercial business within theater for HN development. Time frame for completion of the aforementioned tasks is dependent upon mission, equipment, terrain and weather, time available, troops, and civilian considerations of the geographical area and level of HN requirements.

1-12. The ERC can assist chemical, biological, radiological, and nuclear experts in assessing HN capability for contamination mitigation and decontamination along rail lines, rail yards, and stations. Further, ERC personnel can advise HNs on best practices of hazardous material transportation by rail.

1-13. The ERC can deploy tailorable subordinate teams or crews comprised of key rail personnel based on contingency scale or phase. For phase I thru III of an operation, the entire ERC could deploy. For phase IV and V, or small contingency operations, ERC personnel are employed based on theater requirements. The number of teams required for an operation is dependent upon the viability of the HN government, the HN infrastructure, assets, and resources available. The scalable design offers the flexibility to reduce the ERC as the theater develops and increases availability of Army railway capability on HN rail infrastructure for future conflicts. For example, during phases IV and V HN rail personnel may not have the training or knowledge to establish a front office or business model in a competitive economy or the theater has degraded rail infrastructure and outdated technology. (See JP 3-0 for more information on phasing of a joint operation.)

1-14. In stability operations, the ERC has the capability to help the HN restore essential rail services and support rail economic and infrastructure development. For example, the ERC can conduct training for the HN rail operators, including maintenance training, facilitate the purchasing of spare parts, and fulfill contracting officer's representative roles associated with reconstruction of the railway infrastructure and procurement of supplies and equipment.

1-15. The ERC can also be employed to work in concert with inter-agencies, such as State Department, U.S. Army Corps of Engineers, U.S. Agency for International Development (commonly known as USAID), foreign countries, and nongovernmental organizations. The ERC commander will have the flexibility to assign (a) railway expert(s) or (a) liaison officer(s) in the grade of O-5, O-4, O-3, E-7, or E-6 to inter-agency organizations to synchronize nation building efforts. The ERC and the interagency capabilities will complement one another as all organizations work toward a common goal of improving the HN rail self-sufficiency and capabilities.

SUMMARY

1-16. To meet emerging requirements, the Army redesigned the rail unit structure and formed a single ERC consisting of a headquarters and five deployable railway planning and advisory teams, all totaling 181 personnel. The mission of this organization is not to operate a railroad, but rather to perform capability assessments, serve as the combatant and/or sustainment commander's adviser, and advise and assist HN and contracted rail personnel. The successful use of the rail mode, provided by the oversight of the ERC and its subordinate teams, has the potential to increase movement capability by millions of short tons (STON) during decisive action, and decrease the logistics footprint.

Chapter 2

Rail Transport Operations

There are four primary functions of rail transport operations:

- Train operation.
- Maintenance of way.
- Maintenance of equipment.
- Train control.

North Atlantic Treaty Organization (NATO) and U.S. war plans involve extensive rail use. Today, the ERC is the only remaining U.S. Army rail unit and provides railway planning and advisory teams to advise and assist HN rail organizations and advise the combatant and theater sustainment commander.

RAILWAY SERVICE WITHIN A NORTH ATLANTIC TREATY ORGANIZATION NATION

2-1. Each potential HN in NATO operates a sophisticated, modern railway system. The western area of Europe offers multiple routing possibilities, plenty of marshaling yards, and discharge or loading terminals. Rail line repair and equipment maintenance facilities are dispersed throughout the system. However, the European railway system does pose several potential limiting factors:

- Primary dependence on electrified train operations.
- Civilian population dependence on uninterrupted rail support.
- Long planning and request timelines to coordinate with HN rail providers.
- Rail gauge differences between countries can limit car sizes or result in delays.
- Security issues that create a need for supercargo.

2-2. Personnel should consult and comply with the NATO Standardization Agreement 2455, *Procedures for Surface Movements Across National Frontiers,* before moving trains across NATO borders. American forces must submit forecast movement requirements, including movement requirements based on contingency plans or wartime needs, to the nations concerned in such movement. The standard format used in forecasting movements is shown in the NATO Standardization Agreement 2456, *Movement and Transport Documents and Glossary of Terms and Definitions.*

RAILWAY SERVICE OUTSIDE OF A NORTH ATLANTIC TREATY ORGANIZATION NATION

2-3. While in a non-NATO HN, U.S. Forces must still be prepared to coordinate for the crossing of international borders and border crossing requirements based on specific nations' requirements.

2-4. The ERC's goal is to use the theater's existing rail structure as much as possible to support the theater Army. Extensive rail construction is beyond the capabilities of a military force. See appendix G for additional information on rail facilities construction and rehabilitation.

ESTABLISHMENT OF RAIL OPERATIONS

2-5. Military railroads operate on the same basic principles as commercial railroads. These principles are—

- Locomotives pull railcars loaded with freight and passengers over miles of track.

- Train movements are dispatched through controlled authority methods such as schedule or signal communication.
- Some trains have priority.

2-6. Rail operations in a theater may consist of a broad initial or pre-invasion plan based on limited available information and intelligence. Initial or pre-invasion planning provides general estimates of the potential movement capability of a particular railway system in the theater. One of the primary missions of the ERC is to conduct open source and/or physical reconnaissance on HN rail organizations and infrastructure in order to gather more detailed data. When this data becomes available, the initial plan can be modified.

METHODS OF OPERATION

2-7. Generally speaking, rail transport operations use the following four methods of train operations.

FLEET OPERATION

2-8. This operation (figure 2-1) is the most limiting to railway capacity. Loaded trains are run forward until the tracks at the railhead are full. Trains are then unloaded and returned to the port or point of origin.

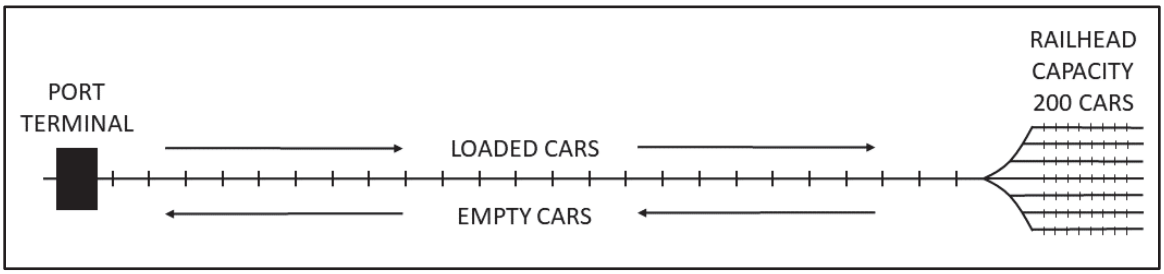


Figure 2-1. Fleet operation

BLOCK OPERATION

2-9. This operation (figure 2-2) permits the train to operate from one block to the next in a station. The two types of block operations used are positive and permissive.

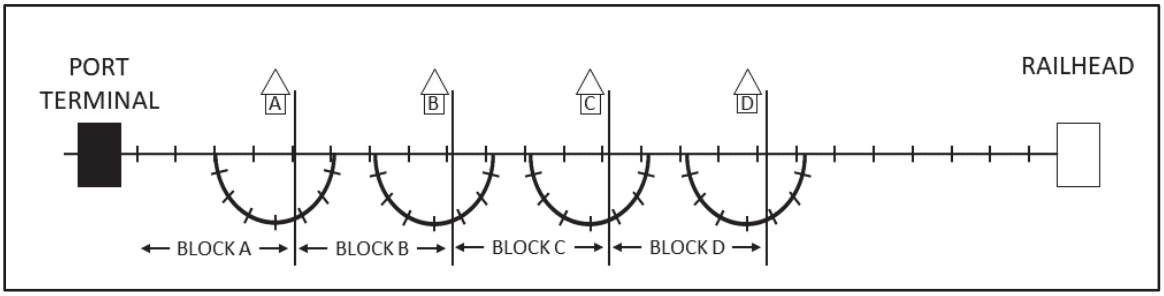


Figure 2-2. Block operation

Positive Block Operation

2-10. In this operation, the use of the block is limited to one train at a time. The train can stop if it is attacked or if the line is obstructed. It can also back up to the last station passed or to a safe place and wait until the track is secure before proceeding. This operation has definite security advantages, but the permissive operation is more efficient.

Permissive Block Operation

2-11. In this operation, more than one train is moving in the same direction. Therefore, the trains may occupy the same block at the same time.

TRAIN ORDER OPERATION

2-12. During this operation, an adequate and dependable communications system must exist. Sufficient sidings (discussed later in this chapter) and passing tracks must also be available. The train dispatcher (or HN equivalent) issues train orders or route clearance and controls movement. A train order remains in effect until it is fulfilled, superseded, or annulled. A train order authorizes movement of trains when not provided for by timetable. For more information on the train dispatcher, see appendix C.

TIMETABLE OPERATION

2-13. Timetable operation is ideal for use when stable rail traffic patterns exist. The timetable contains schedules and special instructions relating to train operation. It is also the authority for movement of trains. Since military train operations usually consist of extra trains not shown in the timetable, use the train order operation in conjunction with a timetable for maximum effect. For more information on timetable operations as it relates to dispatching operations, see appendix C.

Note. During military operations, in a non-permissive environment or where HN infrastructure may have been damaged or destroyed, the four methods of train operation are generally used in the order they were discussed. These progress from the more restrictive fleet and block operations, to the more flexible and precise train order and timetable operations once the situation stabilizes.

TRACK FACILITIES

2-14. In railway terminology, track facilities are defined as those facilities that are required to operate railway trains at a predetermined safe speed. Track facilities include the following:

- Main tracks.
- Sidings.
- Towers.
- Signals.
- Buildings.
- Fuel, lubrication, sanding, and water points.
- Shops.
- Engine houses.
- Communications system.

MAIN TRACK

2-15. The ***main track*** **is a track that extends through yards and between stations.** A main track consists of a single track or two or more tracks on which the current of traffic may run in either direction. Under the U.S. operating system, the block, train order, or timetable, determines its operation. HN rail personnel may have unique methods that U.S. rail personnel may have to learn in order to adequately advise and assist the HN. The following paragraphs discuss the three types of main track operations under the U.S. operating system.

2-16. A main track may consist of a single track or two or more tracks upon any of which the current of traffic may run in either direction. The three types of main track operations are discussed below.

Single-Track Operation

2-17. A single-track operation consists of a single track where trains may run in opposing directions. However, to do this safely, provisions for superior direction, superior trains, and the meeting or passing of superior and inferior trains must be made by the HN operators. For example, U.S. operators use either the train order or the timetable schedule authority for this purpose. The train order or the timetable specifies the superior direction. Trains moving in the inferior direction approaching a train traveling in the superior direction must clear the main track completely by going into a siding 10 minutes before the scheduled arriving time of the opposing superior train unless otherwise directed by train order.

2-18. , When a train dispatcher (or HN equivalent) authorizes an extra train to run over a single-track rail line, they must make provisions for the new extra train to meet all opposing trains. Single-track railway operation not only requires that all operating personnel know, understand, and comply with all provisions of the operating rules, but that they also strictly comply with all orders issued by chief train dispatcher (or HN equivalent). For more information on the chief train dispatcher, see appendix C.

Double-Track Operation

2-19. A double-track operation consists of two main tracks where each track has a designated direction of traffic. No deviation by crews is allowed without specific orders from the train dispatcher (or HN equivalent). The dispatcher must continue to ensure that inferior and superior trains do not meet and that opposing trains are separated. Although double-track operations are simpler than single-track operations, the density of traffic can be two or three times greater than on a single line and the dispatcher is still responsible for the many details inherent in a single-track operation. U.S. operators use either the train order or the timetable schedule authority to specify the flow of traffic and list superior trains.

Multiple-Track Operation

2-20. A multiple track operation consists of three or more tracks where the direction of traffic can be in either direction at any given time. Train density (see chapter 3) is great in this operation. Towers (as directed by the HN equivalent of the train dispatcher) control movement. The dispatcher determines the flow of traffic for each train in order to provide greater movement flexibility and track use. Four tracks are ideal because they can provide high and low speed tracks in both directions and the flow of traffic may be rigidly enforced.

SIDING

2-21. A siding is a track auxiliary to the main track. It is connected by switches at both ends and is used for the purpose of meeting and/or passing trains. Ideally, to prevent delays when two opposing trains contain a greater number of cars than a siding can accommodate, sidings should be long enough to contain the longest train that can be run over the railway line. Sidings should never be used as a loading and/or unloading point except for a serious interruption to traffic or in an extreme emergency.

SPUR

2-22. A spur is a dead-end track auxiliary to the main track. It is connected to the main track at one end and is used to load and/or unload railway equipment. Spurs used as loading and unloading points should be easily accessible to adjacent roads or highways. When two locomotives meet face to face, the spur may provide a place for one to get out of the way.

SWITCH

2-23. A switch consists of moveable rails which can be positioned to allow railroad cars (sometimes known as wagons) or trains to move from one track to another. Power-operated switches are usually found in busy terminals and at interlocking plants on the main line. Manually operated switches are normally equipped with locks for safety purposes (a switch is usually opened to the main track and closed to the spur or siding). The position of a switch is indicated by colored panels.

BRANCH LINE

2-24. A branch line may be either a double- or single-track railway line connecting main lines. It may also be designed to serve relatively remote places, such as industrial plants or sparsely settled areas. Usually, a branch line is constructed of lighter rail and has fewer crossties and poorer ballast than a main line.

CAR ALLOCATION AND DISTRIBUTION

2-25. Cars are allocated for loading based on priorities set by the combatant commander and other higher headquarters (HQ). ERC personnel can liaise with HN rail operators for proper distribution.

DISTRIBUTION

2-26. The HN's equivalent of the car distributor should issue orders for the prompt movement of all available empty cars to loading sites or areas to meet movement requirements. For example, there may be a known and constant daily requirement for 10 tank cars to move petroleum, oil, and lubricant products from depot A, 10 boxcars for ammunition from depot B, 10 flatcars for equipment from depot C, and so forth. The car distributor issues these orders based on information they have received from situation, current station or empty car status, train and yard reports, and reports from adjacent divisions. Yardmasters and station agents, working with the car distributor (or HN equivalents) should have yard switching crews place the empty cars for loading according to programmed and authorized nonprogrammed requirements. For more information on yardmasters and yard switching crews, see appendix E.

2-27. A daily operational and movement conference can make car distribution easier for a port, depot, or other large loading point. Car distribution requirements for the next 12, 24, 48, 72, and 96 hours may be covered. This will allow the HN chief train dispatcher a platform for collecting information they are responsible for passing along to their higher authorities, such as the empty car situation and any inability to meet mission requirements. ERC personnel should likewise inform their higher.

UNAUTHORIZED USES

2-28. Units, depots, or services must not hoard or be given cars without proper authority. Using railcars for storage keeps them out of service, upsets the flexibility of car supply, and disrupts the distribution program. Such practices result in confusion and shortage of equipment already committed for other uses. ERC personnel must report any unauthorized use or hoarding of rail equipment to higher headquarters. The report is then forwarded to the required HN authority for corrective action.

PORT OPERATIONS

2-29. Close coordination is required between rail unit personnel serving at ports and port operating personnel. A large percentage of the tonnage from a port is moved by rail. The smooth operation of a port depends on prompt cargo clearance from the port area.

2-30. Port capacity also depends on prompt movement of cargo from the port area. Since depots, dumps, and storage areas are located within a 20- to 25-mile radius of the ports, movement control teams do not designate rail as the best mode to accomplish port clearance for short distances. Railways are characterized by their capability to move large tonnages over long distances. Movement control personnel coordinate rail movements with the shipper, the receiver, and railway operating personnel. Coordination will expedite port clearance and prevent congestion at yards and/or terminals at origin and destination. Coordination ensures that rail equipment is placed at the desired location, promptly loaded or unloaded, and promptly released to railway operating personnel. Special coordination with all interested agencies is required when ammunition or dangerous commodities are handled.

2-31. Local maintenance facilities may be established when the number of cars used in shuttle service between ports and depots or dumps justifies such action. Contracted car inspectors and maintenance personnel should be stationed throughout the railway network. They perform the following:

- Inspect cars for mechanical defects.
- Make minor repairs (such as replacing air hoses or brake shoes).

- Repair door fastenings, brake rigging, couplers, and so forth.

2-32. Inspectors inspect loaded cars, particularly those containing dangerous commodities, to ensure compliance with clearance requirements and safe loading regulations. They will promptly report cars with defective loads to the appropriate railway operations personnel.

RAIL COMMUNICATIONS

2-33. The American railway communications system exists to fulfill two tasks. The first is to facilitate the efficient operation of the railways. The second is to facilitate routine administration, communication, and logistical functions. In the past, the rail communications system normally consisted of two pairs of open wire pole lines for telephone and teletype circuits. In the modern era, American rail communications uses digital, satellite, and cellular connections for more reliable and cost efficient operations. Many overseas rail organizations have followed suite to further improve their infrastructure and harmonization. In a HN, rail organizations may utilize severely antiquated communications systems, or very similar systems to what is used today in the U.S. ERC personnel must be prepared to advise and assist a HN organization working with anything within the wide range of communications options that are currently utilized. And depending on the state of the HN infrastructure, entirely different methods may need to be developed.

WIRE COMMUNICATIONS SYSTEM

2-34. In the U.S., wire communications were once the primary means of communication for train operations. While many nations now use more modern communication technologies, these technologies are not standard around the world. When operating in a HN environment where wire communication is the chief form of communication, it is recommended the following three communication circuits be established for operations within each division of rail.

- Dispatcher's circuit.
- Message circuit (station-to-station circuit).
- Telephonic and facsimile.

Dispatcher's Circuit

2-35. The train dispatcher, station operators, and tower operators, mainly use this circuit to control trains. A terminal operator may use this circuit to not only control trains entering the terminal from their own division, but also trains being received by, and released to, the adjacent train dispatcher in the connecting division. They also coordinate all train movement responsibilities between connecting divisions for the dispatcher concerned. The train dispatching circuit has a selective ringing device that permits the dispatcher to call stations separately or simultaneously. The train dispatcher is responsible for strict wire discipline and issues orders and instructions in compliance with the rules for movement of trains by train order.

Message Circuit (Station-to-Station Circuit)

2-36. Use this circuit to distribute general information, reports, and records needed for efficient operation. Information obtained must implement orders or instructions issued by the train dispatcher. Use this with the block system operation within a division. Also use this for the following:

- Operational supervision and control.
- Daily and special reports.
- Car distribution.
- Distribution of movement orders to operating personnel.
- Operational matters between stations.

Telephonic and Facsimile

2-37. Telephonic and facsimile communications join one division's train dispatcher with the adjacent division's train dispatcher. Use this communication circuit for written or voice transmission of train consists,

operational orders, movement programs, general instructions, and miscellaneous messages. This circuit may be superimposed upon the message circuit.

POLE AND LINE MAINTENANCE

2-38. Planned and continuous preventive maintenance prevents frequent service interruptions (particularly after heavy storms and in areas subject to enemy action or sabotage). Regular patrols should be established to detect and correct faulty conditions. The nature and frequency of inspection depend on the age, type of poles and lines and the terrain, weather, and other conditions. Regular inspections can normally be made from the ground. However, pole-top inspections should be made often at points in the line where defects are most likely to develop. Inspection crews must be equipped with tools and equipment for making minor repairs and for trimming small branches and vegetation. Unsatisfactory poles, cross arms, and so forth should be replaced. When possible, communication lines should be buried underground.

RADIO COMMUNICATIONS

2-39. Radio is an unsecure means of communication that is subject to exploitation by hostile communications intelligence and electromagnetic warfare activities. However, mobile and fixed radio communications increase efficiency, control, coordination, and safety of train movements. When used appropriately, the advantages of radio communications far surpass the risk involved. When available in a HN, radio communications should be utilized in yards, main track, and other operations. Radio communications in yard operations have the following advantages:

- Yard crews can notify the yardmaster when assignments are complete and immediately receive new assignments.
- Delays at the interlocking plant can be eliminated by knowledge of train location.
- Special movements (such as hospital trains or casualty evacuation) can be expedited.
- Delays caused by derailment or damage to cars or cargo can be reported immediately.
- Arrival time can be determined more accurately through communication with incoming trains.
- Changes in train movements or orders can be rapidly dispersed.

2-40. When radio communication equipment is available, mounting radios in road engines and in way stations extends communications from the way station to the moving train. Main track radio communications furnish contact between trains and the train dispatcher, between trains and way stations, and between stations. Using this equipment has the following advantages:

- The train engineer, in an emergency, can call the way station operator. If the train has to stop, other trains within range of the radio frequency can be advised to take necessary precautions.
- Train speeds can be regulated to ensure proper meetings at passing points.
- Derailments can be reported immediately and repair crews can be quickly dispatched.
- Crossing accidents can be reported and military police and medical assistance can be expedited.
- Train crews, to reduce time at stops, can request fuel or other supplies before arrival.
- The train engineer can be informed of the condition of the tracks as a result of snow and rock slides, flash floods, and bridge washouts.
- Train crews can promptly report guerrilla operations, sabotage attempts, and air attacks.

AUTOMATIC DATA PROCESSING SYSTEM

2-41. If an automatic data processing system is available and to be used in a theater, it must be responsive to the railroad's needs. The type of automatic data processing system used is of small importance to the railway operators, as long as they receive the support needed. The communications system must be able to provide uninterrupted service 24 hours a day. The failure of the communications system to provide this service will completely destroy its value for railway operations.

NEW TECHNOLOGY

2-42. As previously stated, modern rail organizations both within the U.S. and across the world are using cutting-edge new technology within their rail communications systems. These new technologies include—

- The general packet radio service.
- The Intelligent Road and Rail Information Server.

The General Packet Radio Service

2-43. General packet radio service is a non-voice, high-speed wireless communication data service on the 2G (second generation of mobile technology) and 3G (third generation of mobile technology) cellular communication system's global system for mobile communications. It can be used to send and receive both small bursts of data as well as large volumes of data via the internet for computer and mobile phone users. Countries that have, or are in the process of, being combined with this modernization to include this service within their rail communications systems include Italy, Spain, Germany, France, the Netherlands, Belgium, China, Russia, Algeria, Australia, Israel, Saudi Arabia, and others.

The Intelligent Road and Rail Information Server

2-44. The U.S. uses the Intelligent Road and Rail Information Server. HNs around the world may use something similar that ERC personnel will have to become familiar with. The Intelligent Road and Rail Information Server is an internet based portal for viewing, analyzing, and tracking mobile assets on a global basis. Users visualize critical infrastructure to create reports and charts to manage logistics and ensure transportation security. It accesses multiple military databases at once including—

- Strategic seaports.
- Military installations.
- National bridge inventory.
- National railway network.
- National highway planning network.

2-45. The Intelligent Road and Rail Information Server tracks items like road characteristics, bridge locations, video logs of primary routes, feature attribute data, and aerial photo and satellite imagery. The system also provides real time travel information about traffic congestion, weather, road closures, and construction detours. Contact the U.S. Army Corps of Engineers Office of Rail for access and guidance related to these systems.

CYBER THREATS TO RAIL OPERATIONS

2-46. Just as the newest, cutting-edge technologies bring faster and more reliable communications to a rail system, it also brings a host of new threats. The loss of space-based communications due to enemy activity remains a major concern. Whether the interruption of the communications is caused by enemy action against satellites or through the use of intermittent jamming or spoofing, the resulting black-out will require deployed forces to adapt and adjust until the capability is restored. Short term losses or disruptions of satellite communications will have to be mitigated through alternative communications methods and courier networks.

2-47. Over the years, threats from electromagnetic attack and risks to sensitive data networks have increased in number and sophistication. A railroad must be prepared to defend themselves against hackers, terrorists, or other well-resourced enemy organizations whose goal is to breach their communication systems and disrupt operations. Common cyber threats that railroads need to be vigilant against include nation-sponsored, recreational or anti-social hacking, phishing attacks, browser attacks, data breaches, and data theft from internal or external sources. (For more information on joint electromagnetic spectrum operations, see JP 3-85.)

2-48. Within the U.S. railroad industry, companies such as the CSX Corporation frequently upgrade their security systems to protect against cyber threats. While operating in a HN, ERC personnel must encourage the HN rail organization maintain or establish system security. Threat prevention strategies include security

architecture, patch management, intrusion detection and prevention, firewalls, active monitoring, anti-virus software, application security, data encryption, password policies, active process and exception management, education and security awareness, response and containment programs and frequent assessments of vulnerabilities.

2-49. No single method of security should be relied upon. Security should come in layers, such as a filtering layer to prevent attacks from occurring, and a monitoring layer beyond that to catch attacks that were unpreventable. Once an attack does occur, plans should be in place for response and recovery. Just like any other battle drill, these plans should be rehearsed and updated over time. Security should always be adjusting to the latest technologies, enemy tactics, and potential risks and threats. Complacency here will result in an antiquated security system and a vulnerable communications network. One way to check for system vulnerability is to use friendly personnel and resources to attack the system, locate the weaknesses, and recommend changes.

2-50. The HN railroad should also maintain a distinction between their operations networks (those involved in train activity and dispatching) and their administrative network. That distinction is important to prevent a situation where there is an ability to get into operational networks through an administrative connection.

2-51. One resource ERC personnel can turn to for cyber threat expertise and guidance is the Association of American Railroads' Railway Information Security Committee, which was created as the coordination point for sharing experiences and information on effective security practices. The committee, which comprises the railroads' information technology leaders, convenes to discuss concerns, share experiences and talk about security enhancements. The group also periodically runs exercises to test railroads' responses to cyber emergencies.

SUMMARY

2-52. Establishing rail in theater is first based on broad, initial planning that will almost certainly require enhancement after the ERC conducts its initial assessment of a HN's rail capabilities and infrastructure, which is one of its primary missions. Once operations are established, there are several methods of operation, including fleet operation, block operation, train order operation, and timetable operation, which can be used depending on the theater's environment and circumstances. Close coordination of rail operators and port operating personnel will make rail a key mode of transportation to rapidly move cargo through a port. Communication on a rail line is key to successful operations. ERC personnel must work with HN operators in theater through utilization of its liaison officer(s) to establish an effective communication system, either via wire, telephone, radio, cellular, or a combination of some or all of these.

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Chapter 3
Rail Planning

Rail planning consists of determining what type of rail system is needed. It also includes what type of services will be used and who will use and maintain the rail system. HN rail organizations undoubtedly have their own rail planning methods and procedures. This chapter serves as a model that advisors can use to compare and contrast with the HN's methods in an attempt to arrive at the best planning procedure for a specific theater, environment, or situation.

UNIT RAIL PLANNING CONSIDERATIONS

3-1. For large scale rail movements, units should begin planning approximately 180 days prior to required load date. Including the TSC's or ESC's rail planners early in the planning process will prevent duplication of efforts and provide clear planning timeline requirements for commanders and staffs. This initial portion of the rail planning process should include preparation of the unit deployment list in the Transportation Coordinators'-Automated Information Movement Systems (commonly known as TC-AIMS II). Units should plan for and establish a timeline that allows for unit deployment list changes prior to unit deployment list lock dates.

PLANNING TIMELINES

3-2. While timeline requirements vary across the globe and between carriers, many commercial or HN rail partners require 30-45 working days lead time between the carrier's receipt of a mission request and the rail load date.

3-3. Units should incorporate the HN carrier's capacity into their planning. In large-scale rail deployments, the carrier has a limited capacity and capability. Often, HN carriers do not possess adequate cars (such as heavy cargo rail cars) to move brigade sized elements within certain timelines. Rail planners at theater level sustainment units or the attached expeditionary railway center advisors can assist deploying units with these estimates.

3-4. Planners should consider the HN's labor laws and customs when developing planning estimates and milestones. By understanding expected holidays, shift changes, weekends or other time periods of reduced work capacity, commanders and staffs are less likely to develop plans that are not supportable.

3-5. Close coordination with the TSC, ESC, and rail provider will assist in developing a clear understanding of loading times. Load windows often include the processes of the rail provider to spot the cars, configure trains, prepare cars, and inspect, as necessary. These processes can consume a significant portion of the loading window. Rail planners should prepare for loading backlogs and have alternate courses of action or timelines ready if necessary.

LOAD CONFIGURATION

3-6. A train can span many hundreds of meters and loading or unloading platforms are finite. Careful consideration is necessary to prioritize which equipment will offload first in order to best support the receiving unit.

3-7. Consider the pace at which receiving units will need to offload the railcars. Any rail provider emplaced timeline restrictions, rail and loading yard size, and platform size can all influence the speed of which equipment comes off the rail cars. Proper positioning of equipment on rail cars can expedite the egress process.

3-8. Coordination with the TSC, ESC, and/or rail provider can develop better understanding of train length and weight restriction. Planners should use this understanding in designing a complete transportation plan that maximized speed and economy through efficient combination of several modes of transportation.

MISSION COMMAND

3-9. Commanders and staffs should identify potential points of friction during the rail movement and consider placing mission command nodes at these points. Unit liaisons, action officers, maintenance teams, security teams, and vehicles drivers are all potential personnel requirements throughout the rail network that will be necessary to expediently conduct rail operations.

3-10. Planners should understand the material handling equipment and loading logistics working crews available at rail yards. If a rail yard cannot support the large and uniquely shaped military equipment, plan to move the necessary materials handling equipment or personnel separately.

SENSITIVE ITEMS

3-11. Sensitive equipment moving by rail may need a military escort. While the rail carrier can often provide guard cars, the owning unit will be responsible for providing the guard force. Commanders and staffs should understand the nature of the provided guard cars and plan for appropriate accommodations for the guards. These cars are often unpowered while waiting in rail yards for a locomotive and guards may require some augmentation for basic life support.

INTELLIGENCE SUPPORT TO RAILWAY PLANNING

3-12. Rail planners and advisors, either before or after entry into the theater of operation, should gain as much information as possible on the HN rail system. These information requirements should be forwarded to the appropriate intelligence staff for inclusion into the information collection plan and for request for information to higher. The following is a sample listing of information planners should obtain and maintain:

- Types of locomotive. Locomotive manufacturer, model, horsepower number, gauge, mechanical condition, and if spare parts are available in the area of operation.
- Types of rolling stock. Numbers, gauge, loading limits, repair condition, part availability, and distribution within the system.
- Signal system. Type, automation (if any), state of repair, and effectiveness.
- Track structure. Size and type of rails, condition of crossties, rail and ballast, washout and rockslide potential, number of single and double main lines, and the availability of sidings or passing tracks.
- Layout of system. Branch lines, grades, curves, bridges, tunnel and clearance limitation (both height and side clearance).
- Methods of operation (see chapter 2). Mission, equipment, terrain and weather, time available, troops, and civilian considerations will determine windows of operation, commodities, and military requirements. HN stability operations will determine method of traffic, train consists and blocking, routing, and flow priorities.
- Automation available. Communication system(s) available.
- HN railway employees. Employee's level of skill, organizational structure, available training, wages, and work tools available.

RAIL LINE PLANNING AND SELECTION

3-13. Staff and planning functions for theater rail operations are the responsibility of the commander of the highest echelon in the theater. The railway plan that is developed is integrated into the overall movements plan for the entire theater. Selected personnel of the ERC obtain the most detailed information and intelligence through multiple means, to include reconnaissance of HN rail lines. The chief of a railway planning and advisory team, who has been assigned a division of rail line, conducts a reconnaissance of their respective rail divisions and gathers data and information. Utilizing the military decision-making process,

they make estimates of the time required to get the line operational (if not already operational) and the capacity or net tonnage that can be moved over the line. All information collected, intelligence assessments and products produced, and plans and estimates formulated, are then forwarded to the next command level. At the highest level, all the information and estimates are consolidated to form the transportation rail plan. The planner must make assumptions based on current information and on past rail operations experience if the required information is not available or cannot be easily obtained. The following are some important items a planner should consider:

- The strategic importance and selection of certain rail lines. Planned strategy attack, probable objective of the operation, lines of advancement, and enemy strengths and dispositions all influence the selection of primary and alternate rail lines.
- Details shown on maps and photographs (such as the rail routes, the number and location of railway facilities, and the number and kind of structures).
- A general description of the rail system (its facilities and its equipment). These descriptions help the planner to determine the potential capacity of the system, natural and man-made vulnerability, and the importance of the system in the economic structure of the country in which it is located. Descriptions should also give information about the ownership of the railroad, its general operating procedures, and its organization.
- Detailed basic characteristics of routes, facilities, equipment, structures, and operations. These details help the planner to estimate a more accurate rail capacity. Data and information should include details on such items as—
  - Right-of-way, roadbed, and track; types and amount of equipment; supply and maintenance factors.
  - Spare parts, engine house facilities (facilities that contain repair equipment, materials, and tools used to inspect, service, and make running repairs on locomotives), and fuel and water stations.
  - Availability of personnel.
- Types of gauges and classification of railways in the area. General gauge classifications are standard, broad, narrow, and meter. These gauges vary between countries and lines. A large portion of the world considers standard gauge to be 56.5 inches. Broad and narrow are used in relation to a nation's standard. Determining these gauges is part of the rail assessment.

Note. Neighboring countries do not necessarily construct railways with the same type of gauge. Be cautious in using generalized terms such as broad and narrow. In countries that have multiple gauges, a gauge changing station may be located where two different gauges meet. Various methods are used to transfer cargo or mediation of railway cars to continue onward movement.

3-14. The planner must also consider physical features of the area when selecting railways. Considerations include the following:

- Adequate yards, terminals, and shop facilities. Without adequate yards and terminals, main lines become congested. Terminal yards ideally have sufficient track for receiving trains, classifying cars, and making up trains for departure. Tracks should be long enough to receive the longest train (without dividing it into segments) intended to operate on that rail division. Facilities are needed to spot cars, unload them, and promptly return the empties to service. A terminal would ideally include an engine house, car repair tracks, fuel, lube, sanding, and water stations, and buildings to house crews. Finally, adequate shops located at or near yards and terminals to conduct heavy equipment maintenance and repair would be ideal.
- Single, double, or multiple tracks. Train density and overall rail capability are greatly affected by the type and number of tracks. If there is a usable double track, trains may operate in both directions without delays in schedules. However, usable parts of a damaged double track may be made into one single main line with good sidings and passing tracks.
- Seasoned roadbed, good ballast, and heavy rail. The roadbed, ballast, and weight of the rails affect the speed and weight of trains. If the railway with the most seasoned roadbed, the best ballast, and

the heaviest rail is selected, the number of interruptions in train operations caused by washouts and buckled rails are generally reduced. For more information on ballast, see chapter 4.

- Slightest grade and curve. Trains operated in mountains with steep grades require more motive power (all self-propelling equipment found on a railroad, most commonly locomotives). Steep grades usually require pusher engines at the rear of a train, or throughout the train, two or more locomotives pulling at the front of a train (doubleheader), or shorter trains. Train operations in mountainous terrain also reduce the train's speed. Strong pulling and sudden braking are hard on railcars and sometimes cause derailments. These cars require more maintenance than those used on fairly level grade.
- Train speed. Train speed is greatly decreased if the line has sharp or long curves. A speed that can be reached on a straight run of track cannot be maintained on a curved track. The ideal railway, with no grades and no curves, is never realized. However, the rail lines with the slightest grade and the fewest, gentlest curves should be selected.
- Adequate sidings and spurs. Passing tracks should be long enough to permit the longest train on the division to be able to completely clear the main-line track. Sidings and spurs are desirable, but they are not a major basis in selecting rail lines.
- Maximum cargo dimensions and weight allowed. The strength of railway bridges directly affects the kind of locomotives and train weight operated over them. If bridges must be rehabilitated or constructed, they must be strong enough to support the locomotive and the desired train weight. Any tunnels on the railway should have enough clearance for wide and high loads (such as bulldozers and cranes) to pass.

3-15. When selecting rail lines, care must be taken to select those that are the least vulnerable to traffic interruption. The following are some potential natural or manmade bottlenecks, which are vulnerable to enemy action or natural forces:

- Tunnels.
- Long, high bridges, or bridges over deep streams or valleys.
- Deep cuts and high fills.
- Limited access to terminals or yards.
- Tracks located adjacent to banks of streams or rivers (these tracks are subject to the erosive action of flood waters).
- Restrictive clearance points (tracks running through cuts where land and rock slides are common).

LINE CAPACITY PLANNING

3-16. Most military supply movements are primarily forward and military rail-line capacity estimates which are usually based on net tonnage moving in one direction. However, total capacity is based on train density and must take into consideration movements of the train in both directions. When the railway system under consideration is made up of several divisions and/or branch lines, separate estimates should be made for each rail division and branch line. Use the following factors, formulas, and computations for planning considerations. Since locomotives are prime power units, their hauling capabilities must be established. Therefore, to establish a locomotive's pulling power, certain factors must be computed. The factors used are for initial planning and worse case scenarios. Once implemented, or if time permits, plans may be modified.

TRACTIVE EFFORT

3-17. ***Tractive effort*** **is a measure of the potential power of a locomotive expressed in pounds.** It is the horizontal force that a locomotive's wheels exert on a straight, level track just before the wheels will slip on the rails. A locomotive's tractive effort is included in the data supplied by the manufacturer. Where such data are not available, tractive effort may be determined as described in the following paragraphs.

Starting Tractive Effort

3-18. **The power exerted by a locomotive to move itself and its load from a dead stop is *starting tractive effort*.** It is correlated closely to the adhesion that the driving wheels maintain at the rails. If the tractive effort

expended exceeds this adhesive factor, the driving wheels will slip. Normally, the adhesion factor when the rails are dry is 30 percent of the weight on drivers. When the rails are wet, this factor is reduced to 20 percent. However, for planning purposes, 25 percent is used. For a diesel- electric locomotive weighing 80 STONs, or 160,000 pounds, on the driving wheels, the starting tractive effort (STE) is computed as follows:

$$\text{STE} = \frac{\text{Weight on drivers (pounds)}}{\text{25 percent adhesion factor}} = \frac{\text{160,000 pounds}}{4}$$

STE = 40,000 pounds

Continuous Tractive Effort

3-19. ***Continuous tractive effort*** **is the effort required to keep a train rolling after it has started.** As the momentum of a train increases, the tractive effort necessary to keep the train moving diminishes rapidly. The continuous tractive effort (CTE) of a diesel-electric locomotive is approximately 50 percent of its STE. The locomotive cannot continue to exert the same force while pulling a load as was attained in starting that load. The CTE of a diesel- electric locomotive weighing 80 STONs or 160,000 pounds on the driving wheels is computed as follows:

$$\text{CTE} = \text{STE} = \frac{\text{40,000 pounds}}{2}$$

CTE = 20,000 pounds

Drawbar Pull

3-20. ***Drawbar pull*** **is the actual pulling ability of a locomotive after deducting from tractive effort, the energy required to move the locomotive itself**. In planning, 20 pounds per STON of total locomotive weight is taken from the tractive effort to calculate drawbar pull (DBP) as follows:

Total locomotive weight = 80 STONs

80 x 20 = 1,600 pounds

$$\text{CTE} - 1{,}600 \text{ pounds} = \text{DBP or STE} = \frac{160{,}000}{4} = 40{,}000$$

$$\text{CTE} = \frac{40{,}000}{2} = 20{,}000 \quad \text{DBP} = 20{,}000 - 1{,}600 = 18{,}400 \text{ pounds}$$

3-21. Maximum DBP can be exerted only at lower speeds (up to about 10 miles [16 kilometers] per hour) and for a limited length of time. At higher speeds, diesel-electric locomotive DBP diminishes rapidly because the electric generator and traction motor cannot hold up under the heavy starting voltage and amperage. The generator and motor would also burn out if the load continued for a longer time after the locomotive reached a speed of 10 miles per hour (MPH).

Rolling Resistance

3-22. **The force components acting on a train in a direction parallel with the track, which tend to hold or retard the train's movement constitute** ***rolling resistance.*** The following are the components of rolling resistance (RR):

- Friction between the railheads and the treads and flanges on the wheels.
- Resistance due to undulation of track under a moving train.
- Internal friction of rolling stock.
- Resistance in still air.

Note. Although there is no absolute figure to be used as RR, table 3-1 shows the safe average values to use in a theater of operations.

Table 3-1. Safe average values

Track Condition	*Average Value*
Exceptionally good	5
Good to fair	6
Fair to poor	7
Poor	8
Very Poor	9 and 10

GRADE RESISTANCE

3-23. ***Grade resistance*** **is the resistance offered by a grade to the progress of a train.** It is caused by the action of gravity, which tends to pull the train downhill. In military railway planning, use the factor of 20 pounds multiplied by the percentage of grade resistance (GR).

CURVE RESISTANCE

3-24. ***Curve resistance*** **is the resistance offered by a curve to the progress of a train.** The U.S. typically allows from 0.8 to 1 pound per STON of train per degree of curve. In military railway planning, use the factor of 0.8 pounds multiplied by the degree of curvature to calculate curve resistance (CR).

WEATHER FACTOR

3-25. The weather factor (WF) reflects, by percentage, the adverse effect of cold and wet weather on the hauling power of a locomotive. Experience and tests have proven that whenever the outside temperature drops below 32 degrees Fahrenheit, the hauling power of a locomotive is decreased. Table 3-2, shows the weather factor (percent) for varying degrees of temperature.

3-26. Wet weather is usually regarded as local and temporary and is considered absorbed by average figures. However, in countries having extended wet seasons (monsoons, fog, and so forth), the loss of tractive effort due to slippery rails may prove serious if sanding facilities are lacking or inadequate. The applicable reduction is a matter of judgment. However, in general, tractive effort will not be reduced to less than 20 percent of the weight on drivers.

Table 3-2. Effect of weather upon hauling power of locomotives

Most adverse temperature (°F)	*Loss in hauling power (percent)*	*Weather factor (percent)*
Above +32	0	100
+16 to +32	5	95
0 to +15	10	90
-1 to -10	15	85
-11 to -20	20	80
-21 to -25	25	75
-26 to -30	30	70
-31 to -35	35	65
-36 to -40	40	60
-41 to -45	45	55
-46 to -50	50	50

GROSS TRAILING LOAD

3-27. ***Gross trailing load*** **is the maximum tonnage that a locomotive can move under given conditions.** These conditions, for example, include curvature, grade, and weather. When diesel-electric locomotives are operated in a multiple unit operation, the gross trailing load (GTL) is equal to the sum of the GTL for all locomotives used. However, when the locomotives are not electrically connected for multiple unit operation, deduct 10 percent of the total GTL for the human element involved. Determine GTL by combining the factors discussed in the preceding paragraphs and using the following formula:

$$GTL = \frac{DBP \times WF}{RR + GS + CR}$$

Where – GTL = gross trailing load
DBP = drawbar pull
WF = weather factor
RR = rolling resistance
GR = grade resistance
CR = curve resistance

Note. Obtain the GTL by actually testing locomotives as quickly as track and cars become available.

NET TRAINLOAD

3-28. ***Net trainload*** **is the payload carried by a train.** The total weight of the cars under load is gross weight. The lightweight, or weight of empty cars, is tare. The difference between gross weight and tare is the net trainload (NTL) (also called the payload) of the train. For military railway planning purposes, the NTL is 50 percent of the GTL. The formula is computed as follows: NTL = GTL x .50.

TRAIN DENSITY

3-29. **The number of trains that may be operated safely over a division in each direction during a 24-hour period is known as *train density*.** Work trains (trains from which personnel perform track maintenance and construction along the right-of-way between specified points) are not included in computing train density (TD). However, their presence on divisions and the amount of time they block the main track can reduce the density of a rail division. TD may vary greatly over various divisions depending on the following:

- Condition and length of the main line.
- Number and locations of passing tracks.
- Yard and terminal facilities.
- Train movement control facilities and procedures.
- Availability of train crews, motive power, and rolling stock.

3-30. On single-track lines, passing tracks are generally six to eight miles (10 to 13 kilometers) apart. Multiple tracks (three or more) are generally considered as double track, since it is often necessary to remove a portion or all of the third and fourth tracks to maintain a double-track line.

3-31. The capacity or operating turnover of cars and trains into and out of terminal yards must be considered when calculating TD, either from definite experience and available intelligence assessments and products, or by inference from related information.

3-32. The formula for determining single track TD is designed primarily to determine freight TD. Both are reasonably accurate on lines over which passenger trains do not exceed 20 percent of the traffic.

3-33. If enough information is not available to evaluate the potential TD of a rail line, a TD of 10 for single track and 15 for double track in each direction is used for planning.

FORMULA FOR DETERMINING SINGLE TRACK TRAIN DENSITY

3-34. If enough information is available, the following formula is used to determine TD for a specified railway division. In determining the number of passing tracks, do not include those less than 5 miles (8 kilometers) apart. Passing tracks should be uniformly spaced throughout the division.

$$TD = \frac{NPT + 1}{2} \times \frac{24 \times S\ 2}{LD}$$

Where – TD = train density
NPT = number of passing tracks
1 = constant (number of trains that could be run if there were no passing tracks)
2 = constant to convert to each direction
24 = constant (number of hours per day)
S = average speed (table 3-3)
LD = length of division

Note. When the computation for TD results in a fraction, the result is raised to the next higher whole number.

Table 3-3. Determining average speed value

Average Speed					
Condition of track	***Percent of grade***	***Single track***		***Double track***	
		mph	***kph***	***mph***	***kph***
Exceptionally good	1.0% or less	12	19.3	14	22.5
Good to fair	1.5% or less	10	16.1	12	19.3
Fair to poor	2.5% or less	8	12.9	10	16.1
Poor	3.0% or less	6	9.6	8	12.9
Legend: mph = miles per hour kph = kilometers per hour					
Notes: 1. The most restrictive factor governs the speed selected. 2. Consider the following when using the table for average speed factor: A. If the condition of track and/or the percent of grade are not known, use an average speed value of 8 mph for single track and 10 mph for double track. B. Where the most restrictive factor occurs for a comparatively short distance – that is, less than 10 percent of the division – use the next higher speed. C. Where average speed falls below 6 mph because of the grade lines, reduce the tonnage to increase speed (2 percent reduction in gross tonnage will increase speed 1 mph).					

NET DIVISION TONNAGE

3-35. ***Net division tonnage*** **is the tonnage in short tons, or payload, which can be moved over a railway division each day.** Net division tonnage (NDT) includes railway operating supplies that must be programmed for movement. The formula for NDT is: NDT = NTL x TD. Compute NDT separately for each division.

END DELIVERY TONNAGE

3-36. **The *end delivery tonnage* is the through tonnage, in short tons, of payload that may be delivered at the end of the railway line (railhead) each day.** In an all-rail movement, the end delivery tonnage (EDT) equals the NDT of the most restrictive division.

RAIL YARDS

3-37. A rail yard is a system of tracks within defined limits used for making up and breaking up trains, and storing cars. Yards may be located at railheads, depots, interchange points, ports, or terminals. Yards may also contain any number of tracks. The number and length of inbound and outbound trains determines the number and length of tracks. Railroad yards are natural bottlenecks in the movement of freight from one geographical area to another. In theory, cars may enter the receiving end of a yard as fast as they arrive. However, in practice, they can only depart as fast as the yard personnel can inspect, repair, classify and switch, and double them according to their setoff order. The two kinds or rail yards are progressive yards (further broken down into receiving yards, classification yards, and departure yards), and combination yards. For more information on the procedures and operation of yards, see appendix E.

PROGRESSIVE YARD

3-38. A ***progressive yard*** **is a multifunctional yard structured to move cars in a fluid and rapid manner, containing receiving, classification, and departure yards.** They are mainly located at busy terminals. A progressive yard is subdivided into receiving, classification, and departure yards. Cars move through each of these sub-yards in a progressive manner.

Receiving Yard

3-39. A ***receiving yard*** **is where trains are cleared promptly on arrival to prevent main line congestion.** They are also called receiving tracks. As a train approaches the terminal area, it enters the yard by a lead track and clears the main line so that other traffic is not tied up.

Classification Yard

3-40. The classification yard is next to the receiving yard. In the classification yard, cars are sorted or classified according to destination and priority of movement. The destination may be to a local depot or supply point, a branch or connecting line points farther up the line, or a neighboring station or local industry.

Departure Yard

3-41. Once cars are classified, they are switched to the departure yard. The ***departure yard*** **is the yard where classified cars are made up into trains.** The cars are grouped from front to rear in the order in which they will be set off en route or in the order that will make switching easier at the next terminal.

Combination Yard

3-42. A ***combination yard*** **is a yard that is a combination of receiving, classifying, and departure facilities.** Railroads frequently incorporate the receiving, classifying, and departure facilities into one as a result of insufficient volume of work to justify three separate yards or from a lack of land to expand the yard layout.

YARD CAPACITY DETERMINATION

3-43. The capacity of the yard needs to be determined based on planning factors and planning formulas. The following describes the planning factors and planning formulas for classification yards. Also described below are the planning factors for terminals with and without receiving and forwarding yards.

PLANNING FACTORS FOR CLASSIFICATION YARDS

3-44. The following factors are based on day and night operations and may be used for planning purposes. Where two or more main line railways intersect at a major terminal, the facilities will have to be duplicated accordingly.

3-45. Flat switching capacity is 30 cars per locomotive per hour. This includes time for switch engines (motive power used to switch cars within yards or at division terminals) to push cars into the yard (based on foreign equipment). Hump switching capacity is 45 cars per locomotive per hour.

3-46. The numbers of cars, at any given time, in a classification yard should not exceed 60 percent of the yard's capacity. When cars exceed yard capacity, switching room decreases and operating efficiency is sacrificed.

3-47. Length of track in a classification yard generally is one train length, plus 20 percent, plus 300 feet (91 meters). Track and/or train length varies with local terrain characteristics and railway equipment and requirements.

3-48. Depending on the yard layout, the number of switch engines per shift that may be employed in the operation of the loaded freight classification yard may vary from one to three. Therefore, one switch engine may handle 30 to 60 cars per hour and three switch engines may handle 90 to 180 cars per hour. Functions for switch engines include the following:

- One switch engine at the head of the receiving yard, preparing cut of cars for switching.
- One switch engine switching cut of cars into the classification yard.
- One switch engine at the opposite end of the classification yard, coupling cars and making switching room.

3-49. During slack traffic periods, one switch engine may be used for all functions above. The switch engine functions above are also used in the classification yard proper and do not include those engaged in supporting other terminal operations.

3-50. The average time a car remains in the classification yard is 8 hours. Classification yard traffic changes an average of three times per day. (Some cars may be held 48 hours; others may clear in less than 8 hours.)

PLANNING FORMULAS FOR CLASSIFICATION YARDS

3-51. Use the following formulas to determine classification yard requirements and capabilities. Determine the required length of yard tracks using the following:

$$LT = ACT \times LC \times 1.2 + 300 \text{ feet (91 meters)}$$

Where –
- LT = length of track
- ACT = average cars per train
- LC = average length of car
- 1.2 = operational factor (to allow for overall length of car coupler)
- 300 feet = clearance distance at each end of track from point of switch to clearance

3-52. Determine the minimum number of tracks using the following:

$$NTR = \frac{TDs}{3} \times 1.6$$

Where –
- NTR = number of tracks required.
- TDs = sum of train densities of using divisions
- 3 = turnover per day.
- 1.6 = 60-percent factor of static capacity.

Note. When computing requirements for a terminal yard, the result obtained in this formula must be doubled. The formula does not necessarily apply to railheads since classification of cars is not always necessary at railheads.

3-53. Determine static yard capacity using the following:

$$SYC = ACT \times NT$$

Where – SYC = static yard capacity (in cars)
ACT = average cars per train
NT = number of tracks of the length necessary to accommodate the ACT

Note. Daily yard capacity is equal to 1.6 times SYC. This figure takes into account the number of cars in a yard at any given time will not exceed 60 percent of the static capacity.

PLANNING FACTORS FOR TERMINALS WITH AND WITHOUT RECEIVING AND FORWARDING YARDS

3-54. The following factors are based on how trains are moved in the terminal. These factors may be used for planning purposes.

With Receiving and Forwarding Yards

3-55. Where trains are operated into and out of terminals at 48-minute intervals, there should be a minimum of six tracks plus one runaround track in both the receiving and forwarding train yards to handle empty and loaded trains. In general, the number of tracks required equals the TD divided by 5, plus 1.

$$NT = \frac{TD}{5} + 1$$

Without Receiving and Forwarding Yards

3-56. Normally, receiving and forwarding train yards will be in balance with classification and main line capacity. However, some railways dispense with receiving and forwarding yards and operate all trains directly into and out of classification yards. In such cases, the classification yard's daily capacity is reduced by approximately 25 percent.

TWO-WAY TONNAGE TRAFFIC IN TERMINALS

3-57. Where there is two-way tonnage traffic in large terminals, the various yards are normally designed with yards for each direction. For example, northbound receiving, classification; forwarding yards and southbound receiving, classification; and forwarding yards.

RAILWAY EQUIPMENT PLANNING

3-58. The categories of equipment requirements considered when planning are as follows:

- Rolling stock, consisting of boxcars, gondolas, flatcars, tank cars, refrigerator cars, and hopper cars.
- Road engines, the motive power used to pull trains between terminals or division points.
- Switch engines, the motive power used to switch cars within yards or at division terminals.

ROLLING STOCK

3-59. There are three classes of railway rolling stock: freight, passenger, and special.

Freight

3-60. Compute requirements separately for operations between major supply installations or areas on each rail system. Use the following formula to compute requirements.

$$\text{Total cars required} = \frac{\text{EDT (by type car)}}{\text{Average payload for type car}} \times \text{TAT} \times 1.1$$

Where – EDT = end delivery tonnage
TAT = turnaround time

3-61. Obtain the first factor of this formula from that part of the computation for 1 day's dispatch which determines the number of cars required by type to transport all or a given portion of the EDT of a rail system (see appendix B, third computation).

$$1\ DD = \frac{EDT\ (by\ type\ car)}{Average\ payload\ for\ type\ car}$$

3-62. The number of cars dispatched in a day from the base of operations is 1 day's dispatch. For planning purposes, the number of cars dispatched from a division terminal, railhead, or other dispatch point is considered the same as the number dispatched from the base of operations. Use the formula shown above to determine the rolling stock for 1 day's dispatch. Computations are made for each type of car to be used (boxcars, gondolas, and/or flatcars) and the sum of the results for all types of cars that are computed are 1 day's dispatch for the system.

3-63. Turnaround time is the estimated number of days required from the time the car is placed at the point of origin for loading until it is moved to its destination, unloaded, and returned to its point of origin. Time may be computed as follows: 2 days at origin, 1 day at destination, and 2 days in transit (1 day forward movement, 1 day return movement) for each division or major portion of each division which the cars must traverse. This method, rather than an actual hour basis, is used to incorporate delays due to terminal and way station switching as well as in-transit rehandling of trains.

3-64. The 1.1 factor is used to express a 10-percent reserve factor. The reserve factor provides for extra cars to meet operational peaks, commitments for certain classes of cars, and bad-order cars (cars needing repair).

3-65. Compute planning factors for net load per freight cars by using 50 percent of the rated capacity for all freight cars except tank cars. Tank cars are rated as carrying 100 percent of their capacity.

3-66. Compute tank car requirements separately based on bulk petroleum, oils, and lubricants requirements, tank car capacities, and computed turnaround time.

Passenger

3-67. Passenger car requirements vary depending on troop movement policies, evacuation policies, and rest and recuperation policies. Compute passenger car requirements at 10% below the seating capacity of the car type when only passengers are moved. If passengers are hand carrying organization clothing and individual equipment, compute 50% below seating capacity.

Special

3-68. Special equipment is that equipment used exclusively by the railroad for its own use. This type of equipment includes maintenance of way equipment, work cranes, snow or land removal equipment, locomotives, and so forth.

ROAD ENGINES

3-69. Determine the number of road engines required for operation over a given railway division by using the following formula:

$$Road\ engines\ required = TD \times \frac{(RT + TT)}{24} = x\ 2\ x\ 1.2$$

Where – TD = train density
RT = running time (length of division divided by average speed)
TT = terminal time (time for servicing and turning locomotive is 3 hours for diesel-electric locomotives and 8 hours for steam locomotives)

24 = number of hours per day
2 = constant for two-way traffic
1.2 = constant allowing 20-percent reserve
$\frac{(RT + TT)}{24}$ = engine factor (time a road engine is in service).
The engine factor provides for motive power, which may make more than one trip per day over a short division.

SWITCH ENGINES

3-70. No two ports, divisions, or terminal railheads are alike in design or operation. However, the functions of the main yards in each are essentially the same. ***Switch engines*** **are the type of motive power used for receiving cars, classifying, and reassembling them for delivery or forward movement.**

3-71. The number of switch engines required at a terminal is based on the number of cars dispatched and received at, or passing through, the terminal per day. When the number of cars has been computed, apply that figure to the factors shown in table 3-4 to determine the number of switch engines required at each terminal.

Table 3-4. Switch engines required

Location	***Switch Engines Required***
Port or loading terminal	1 per 67 cars dispatched and received per day
Division terminals	1 per 100 cars passing per day
Railhead or unloading terminals	1 per 67 cars dispatched and received per day

3-72. When the total number of switch engines required for the railway line has been computed, 20 percent is added as a reserve to allow for maintenance, operational peaks, and so forth.

RAILWAY PERSONNEL PLANNING

3-73. The following sections provide guidance on how to advise planners in the HN rail system on the managing of their operating crews.

ROAD CREWS

3-74. In computing the number of road crews desired for each division, preparation time is included. Preparation includes the following:

- A two-hour period at the originating terminal for the crew to receive orders and instructions, test the air, and check the train.
- Running time involved, which is computed by dividing the length of the division by the average speed of the train; if information is not available to compute the speed, the speed may be assumed to be 10 miles per hour; normally, running time over a division will be about 12 hours.
- A one-hour period at the final terminal to submit necessary reports.

3-75. To allow enough time for the crews to rest, the running time normally does not exceed 12 hours. Although experience shows that safety and efficiency decrease when crews work continuous daily shifts of more than 12 hours, this time can be exceeded in a worst-case scenario situation during combat operations by the authority of the senior HN operator in charge. Despite it being illegal on an American railroad, even during an emergency, in a HN during combat operations, it is possible to work shifts of 16 to 18 hours, if the crews have enough rest periods before reporting to operate another train. Sometimes it will be necessary to designate longer hours because of the length of the division involved. In such cases, enough time off between operating trains should be permitted to limit the average daily shift to 12 hours.

3-76. When determining the number of road crews needed per division use the following formula.

$$\text{Number of road crews} = TD \times 2 \times \frac{(RT + 3)}{12} \times 1.25$$

Where – TD = train density

2 = factor to convert to two-way traffic
RT = running time (length of division divided by average speed)
3 = 2 hours allowed for preparation at originating terminal, plus 1 hour at final terminal
12 = 12-hour shift per road crew per day
1.25 = constant factor to allow for ineffectives

YARD SWITCHING CREWS

3-77. To determine the number of yard switching crews required, the number of switch engines in use at each terminal must be known. Two crews are required per switch engine per day. Use the following formula to determine the number of switching crews required for each terminal (do not compute crews for reserve switch engines).

Number of switching crews = SE x 2 x 1.25

Where – SE = number of switch engines
2 = crews per engine
1.25 = constant factor to allow for ineffectives

SUPPLY REQUIREMENTS

3-78. Railway supply tonnages are normally quite large. Planners, when computing EDT, should ensure that all concerned persons understand that supply tonnage must be deducted from EDT to arrive at the actual figure that will be delivered to the units at the railhead. The following paragraphs discuss the method of arriving at specific supply requirements for fuel, lubricants, and repair parts.

FUEL CONSUMPTION OF DIESEL-ELECTRIC LOCOMOTIVES

3-79. Table 3-5 contains an estimated average rate of diesel fuel oil consumption in gallons per train-mile for diesel-electric road locomotives and in gallons per hour of operation for switch engines. For planning purposes, the operation of switch engines is assumed to be 20 hours per day. The method of determining fuel oil requirements in gallons for road locomotives and switch engines is as follows.

Table 3-5. Fuel requirements for diesel-electric locomotives

Estimated Average Rate of Fuel Oil Consumption			
Type of Locomotive	***Type of Operation***	***Gallons Per Train-Mile***	***Gallons Per Hour***
**Standard gauge:*			
C-C, 120-STON	Road switcher	2.5	11.5
B-B, 50-STON	Road switcher	0.9	8.0
**Narrow gauge:*			
C-C, 80-STON	Road switcher	1.5	10.0
B-B, 48-STON	Road switcher	0.9	8.0
Legend: STON = short ton			
* When computing fuel requirements and the table does not provide for an engine wheel match and/or tonnage match, the next largest wheel or tonnage figure should be used.			

3-80. The following is the method of determining fuel oil requirements, in gallons, for road locomotives:

- Multiply the TD of the first division by 2 (for two-way travel), then multiply the result by the length of the division; this result is the train-miles per day for the division.
- Repeat this procedure for each division of the system.
- Total the daily train-miles for all divisions.
- Multiply the total daily train-miles by the fuel consumption factor to obtain the daily fuel requirement.

- Multiply the daily fuel requirement by 30 to obtain the monthly fuel requirement; add 5 percent to this computed total to provide a reserve for contingencies.

3-81. The following is the method of determining fuel oil requirements, in gallons, for switch engines:

- Multiply the total number of switch engines required (do not include reserve engines) by 20 to determine the total hours per train-day of operation.
- Multiply the total hours per train-day of operation by the fuel consumption factor of the engine concerned (table 3-4 on page 3-13); this result is the daily fuel requirement in gallons.
- Multiply the daily fuel requirement by 30 to obtain the monthly fuel requirement.
- Add 5 percent to this computed total to provide a reserve for contingencies; when coal is the fuel, use a reserve factor of 10 percent.

LUBRICANTS

3-82. Use lubricants on all moving parts of railway tools, appliances, machinery; and on all motive power and rolling stock. For planning purposes however, only the lubricants necessary for the operation of motive power and rolling stock are based on an estimate of 1,000 pounds per month for each train moving in either direction over each division in one day. Use the following method to determine the amount of lubricants required:

- Multiply the TD of the first division by 2 (for two-way travel); then multiply the result by 1,000; this gives the amount in pounds of lubricants required per month for the division.
- Repeat this procedure for each division of the system.
- Total the amount of lubricants for all divisions to determine the grand total of STONs required per month for the railroad.

REPAIR PARTS

3-83. The rail industry in any HN has likely been operating for decades with a functioning industry of repair parts and other supplies. However, the nature of warfare may disrupt the HN industry. The number and kinds of supplies and repair parts will possibly be unavailable to maintain the motive power and the rolling stock used by the HN. For planning purposes, only the repair parts necessary for the maintenance of motive power and rolling stock are considered. An estimate of repair parts required is based on a factor of 1.5 STONs per month for each train moving in either direction over each division in one day. Use the following method to determine repair parts required:

- Multiply the TD of the first division by 2 (for two-way travel).
- Multiply the result by 1.5 to get the total amount in STONs of repair parts required per month for the division.
- Repeat this procedure for each successive division of the system.
- Total the amounts to determine the grand total of STONs required per month for the entire railroad.

3-84. Good judgment and certain assumptions are required when making allowances for railway operating supplies. It is assumed that all trains operated over each division are tonnage trains and that each division requires the same amount of operating supplies. The above formulas are an accepted method for computing operating supplies from a broad spectrum; however, a more refined method would employ the following methodology in making allowances:

- First division. No allowance is made, since the operating supplies are available at the port terminal or base of operations.
- Second division. An allowance of 5 percent of the first division net tonnage, which means only 95 percent of the first division net tonnage, will be hauled over the second division.
- Third division. An additional allowance of 5 percent of the first division net tonnage, or a total deduction of 10 percent of the first division net tonnage, which leaves only 90 percent of the original tonnage to be hauled over the third division.
- Additional division. An additional allowance of 5 percent of the first division net tonnage will be made for each successive division, with a corresponding reduction in tonnage hauled.

SUMMARY

3-85. The first thing that a rail planner must do is select the rail lines that will be used during an operation. This is a complicated process that starts with reconnaissance to determine the current state of existing infrastructure, rail facilities that are present and available, physical features of an area, and the vulnerability of certain rail lines to traffic interruptions. The line capacity of the rail lines is also a key factor in the planning process. Several calculations, including tractive effort, drawbar pull, rolling resistance, and train density, all go into line capacity determination. In addition to line capacity, yard and terminal capacity is vital to rail planning. Yard classification affects yard capacity and how the yard is used. Terminal capacity is based on how trains move through the terminal, and what yards are available to the terminal. Additionally, planners must consider the necessary railway personnel, including road crews and yard switching crews, to conduct railway operations. Finally, supply requirements must be taken into account. Repair parts will be required as well as other maintenance items like lubrication products in order to conduct a successful rail operation with any kind of operational endurance.

Chapter 4

Rail Structure and Reconnaissance

Railway structure is of strategic and tactical importance to the combatant and sustainment commander. General estimates of potential rail capability may be utilized for initial or pre-invasion planning. However, detailed reconnaissance to determine the condition and characteristics of track, yards, terminals, shops, and other facilities is required in order to modify the initial plan. The personnel of the ERC have this responsibility.

Note: The below terms apply to U.S. railroads. Ensure terms of the HN railroad are used to avoid miscommunication of reporting or intent.

TRACK AND STRUCTURES

4-1. The track is the most important and most vulnerable part of a railway system. It usually crosses many miles of undefended territory. The track and structures are composed of many items designed to provide a smooth and strong riding surface for rail traffic.

COMPONENTS AND FUNCTIONS

4-2. The following paragraphs and figure 4-1 on page 4-2 describe railroad track main components and their relationships.

SUBBALLAST

4-3. ***Subballast*** **is gravel, sand, or cinders used to provide a level surface for the ballast and other track components.** It is inferior to ballast. It is spread about half the depth of the total ballast section and should never be less than 6 inches deep. Using subballast does the following:

- Saves higher quality stone for the ballast.
- Seals off contact between the ballast and the subgrade, which allows better drainage.
- Prevents indentation in the subgrade caused by ties under the weight of the train.

BALLAST

4-4. Ballast is crushed rock or broken stone laid between ties and the subgrade to provide additional support for the track. If subgrade is not used, the ballast will be laid no less than 12 inches in depth from the bottom of the tie. The two types of ballast are mainline and yard ballast. Mainline ballast is larger in size (3/4" to 2" square) while yard ballast is smaller in size (3/8" to 1" square). Wooden, concrete, composite, or steel crossties (sometimes referred to as sleepers in European nations) are laid across the ballast to support the rail. Tie plates and rail anchors are laid on the crossties. The rail is then secured to the crossties with spikes or screws. Sections of rail are then connected at the ends and the joints are bolted or welded to complete the track.

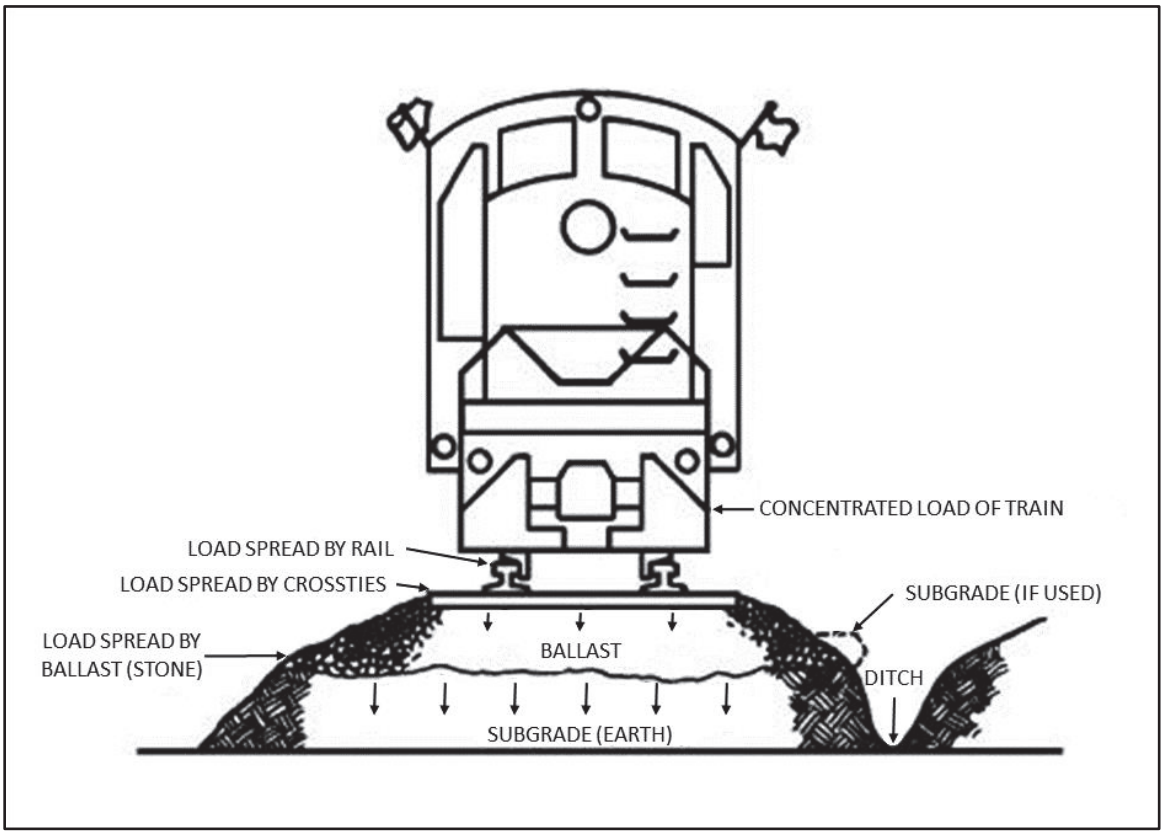


Figure 4-1. Main components of a railroad track

4-5. Materials best used as ballast are trap rock, granite, limestone, quartzite, and dolomite. For heavy tonnage and/or high speed traffic, broken or crushed stone is the most desired ballast. Other common but poorer ballast material is pit-run gravel, engine cinders, oyster shells, decomposed granite, and sand. However, sand may be used for light traffic lines. It is easily obtainable and drains reasonably well; but is difficult to tamp when dry, erodes easily from wind and rain, and collects dirt quickly. Ballast is usually locally available materials.

4-6. In order to perform its function, ballast must be resistant to water and weather, coarse for rapid drainage, fine enough to facilitate handling, and angular to resist movement. Using ballast does the following:

- Distributes the weight of the trains on the track.
- Keeps the track from moving under the weight of the trains.
- Provides adequate drainage for the track.
- Maintains proper track leveling and alignment.
- Retards growth of vegetation.
- Reduces dust.
- Distributes the load of the track and train to prevent overstressing the subgrade.
- Restrains the track laterally, longitudinally, and vertically under dynamic loads imposed by trains and thermal stress induced in the rails by changing temperatures.

Cross And Switch Ties

4-7. Crossties support vertical rail loads (train weight) and distribute those loads over a wider area of the supporting material (ballast). Crossties provide a smooth surface onto which the rail can be fastened, therefore resisting rail movements caused by train movement. Crossties also provide a means to fix and maintain the gauge (distance) between the rails.

4-8. Crossties are currently used mainly on conventional track. Regardless of their shape, dimensions, or composition, crossties perform many functions necessary for an operational railroad track.

- The timber crosstie is used most often in the U.S. The tie is cut from mixed softwoods and hardwoods and is treated with creosote, creosote-coal tar, or creosote petroleum solutions to prevent or retard fungi, bacteria, insects, borers, and decay. The treated timber tie varies in dimensions: 5" x 5" to 7" x 10" in cross sections, 8 feet to 9 feet in lengths for standard crossties, and 9 feet to 23 feet for switch ties and crossover ties. The standard U.S. mainline crosstie (7" x 9" x 8’6") weighs approximately 250 pounds.
- The concrete crosstie has the same general dimensions as the timber crosstie, but is almost twice as heavy. Most concrete crossties have direct fixation fastenings with a cushioning pad between the tie and the rail base. These fastenings can be either a threaded type or a threadless type. In any of its forms, fastening is the weakest part of the concrete crosstie system.
- Plastic crossties are similar in weight to wooden crossties and may be used to replace a defective wooden tie. Refer to the Unified Facilities Guide Specification, Section 34 11 00 for material requirements.
- Composite crossties are made of a composite lumber material that is a mixture of wood fiber, plastic, and a binding agent. These ingredients are manufactured to form a wood-plastic composite material that is denser, stronger, and heavier than wood alone.
- Steel crossties are tough, flexible, and resistant to mechanical deterioration. They are manufactured in a variety of shapes and include special features such as an integral fastening system. They are not normally found in trackage that has an electric current as part of a signal system or in an electrically powered railway system. Recent innovations have seen the manufacture and use of recycled plastics and automobile tires in the manufacture of crossties.

4-9. Switch ties are specially cut and formed crossties, designed mainly to support switches, switch stands, and the moveable rails of the switch. Switch ties should be made of hardwood.

RAIL

4-10. All parts of the track are essential. However, the rail is subjected to the greatest stresses and which is basic to the energy saving efficiency of railroads.

CONSTRUCTION

4-11. Rail steel contains iron, carbon, manganese, and silicone. Impurities sometimes found in steel are phosphorous, sulfur, and slag. Rail is identified by its weight per yard and its cross-sectional shape design. The rail weight is referred to as its nominal weight per yard or meter, such as 115 pounds per yard and 52 kilograms per meter. Common rail weight standards found in the U.S. are 130 pounds, and UIC 60 (named after the Union Internationale des Chemin, or International Union of Railways, and is equivalent to approximately 132 pounds) in Europe and Southwest Asia. Rail can be manufactured in many different lengths. In the U.S., the standard lengths for rail are 39 feet and 78 feet. Lengths in many other countries are similar.

Joints

4-12. Rail can be constructed into a track in two ways. It may be jointed (conventional construction) or welded (continuous welded rail).

4-13. In conventional construction, the 39-foot rail sections are joined together using bolts and joint bars. The 39-foot rail sections are welded together at central rail welding plants. One quarter-mile long strings are welded in place using the thermite welding process. Normally the only welds you find in 39-foot jointed rail are found at road crossings and bridges. For continuous welded rail, the ties are normally closer together and requires more and a better quality of ballast.

Rail Anchors

4-14. Rail anchors (figure 4-2) are installed on the rail base securely against the side of the tie. Anchors are designed to resistor check the longitudinal movement of the rails under traffic. They also maintain proper expansion and contraction forces that build up in continuous welded rail. Without anchorage, the rail will run irregularly. At locations where expansion forces concentrate, the track can buckle or warp out of line or surface. At locations where contraction forces concentrate, the field welds can be broken or the bolts can be sheared.

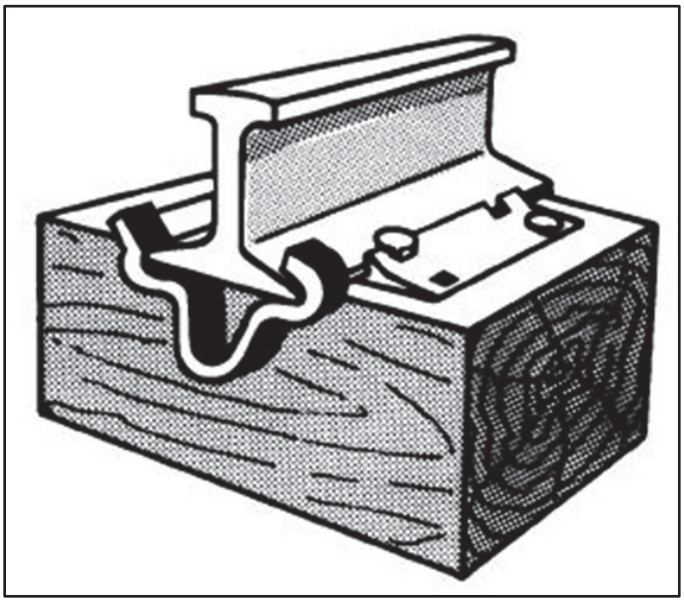


Figure 4-2. Simple rail anchor on base of rail

Tie Plates and Fastenings

4-15. Tie plates (figure 4-3) protect the wooden crosstie from damage under rails and distribute wheel loads over a larger area. They also hold the rail at the correct gauge, tilt the rail slightly inward to help counter the outward lateral weight of wheel loads, and provide more desirable positioning of the wheel bearing area on the rail head.

- Application. Tie plates are attached to the ties by spikes, screws, or other fasteners. Attachments are installed into the tie through the holes manufactured into the tie plate. Some of the spikes (or other fasteners) in each plate also hold the rails in the rail seat formed in the tie plate.
- Functions. There are three primary functions of any rail fastening system. These functions are as follows:
  - Transfers the wave motion of the rail (which precedes and follows a wheel) to the tie, which will cushion the shock.
  - Provides an anchoring force to help restrain longitudinal movement of the rail.
  - Holds the rail alignment, while still providing a slight vertical flexibility.

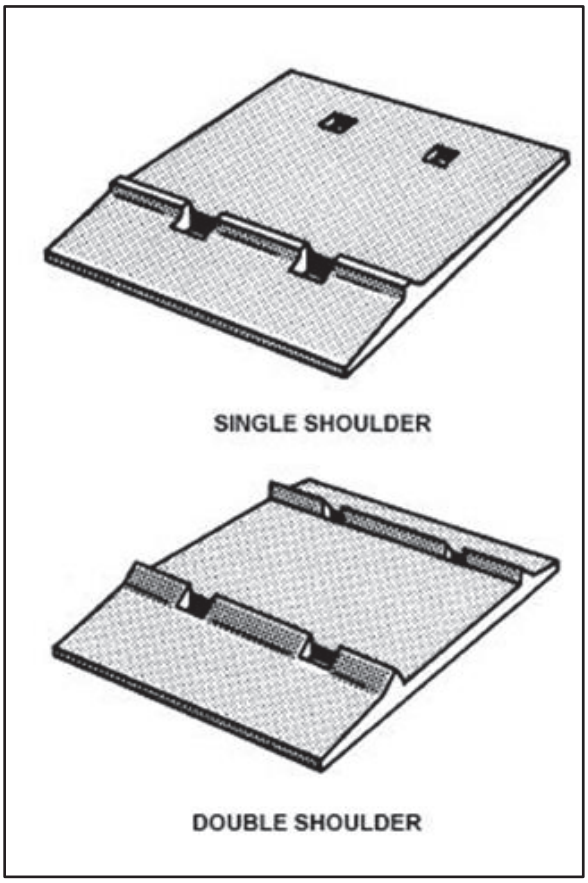


Figure 4-3. Tie plates

Track Spikes

4-16. Hook head or cut spikes are used extensively in the continental United States and in military railroading. Screw spikes are used primarily in Europe. Four to eight spikes are used per tie (figure 4-4 on page 4-6). Use four spikes on straight track and eight spikes on curved track. Track spikes (figure 4-5 on page 4-6) do the following:

- Holds the rails to the correct gauge and alignment.
- Prevents the rail from overturning.
- Secures tie plates to the ties.

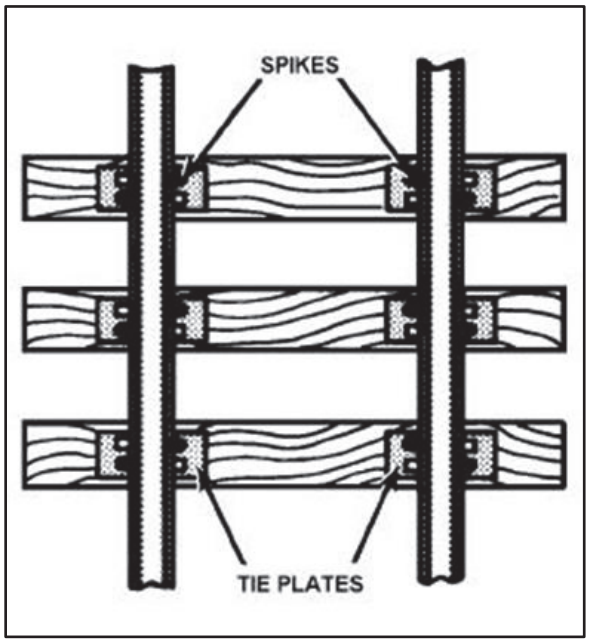


Figure 4-4. Correct method of setting spikes

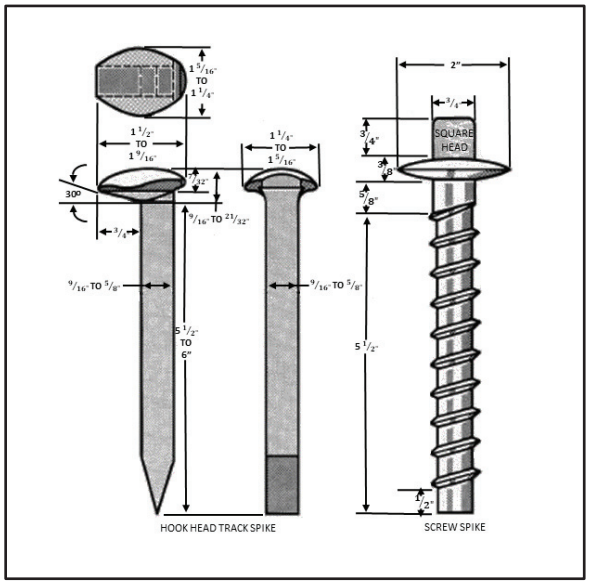


Figure 4-5. Spikes

Rail Joints and Accessories (Splice Bars)

4-17. Rails must be connected at the joints so the rails will act as a continuous girder with uniform surface and alignment (figure 4-6) shows a misalignment utilizing joint bars to repair the issue). Therefore, inspect all rail joints and accessories obtained from suppliers or storage before they are placed in track.

4-18. Special bars consist of insulated, heel, and compromised joint bars. An insulted joint, also called an IJ, is commonly used when near a signal or crossing specifically to block the electrical current used to detect a train or track vehicle on the rail. Heel joints are used specifically at switches to decrease the difficulty of its use. They are assemblies of heel block, a special bent joint bar, and heel block bolts.

4-19. The primary purpose of any rail joint is to maintain the fixed relationship of the abutting rail ends and to provide a structural means of transferring the wheel loads from one rail to another. If possible, the rail joint should have the same strength and stiffness as the rail. This can be done by using two steel members. They fit in the space on each side of the rail and span the gap between the two rails. These compromise angle bars are normally held in place by bolting.

4-20. The track bolt, spring (lock) washer, and nut are the most commonly used joint accessories. The track bolt is made from heat-treated, high-carbon steel. It has an elliptical neck under the bolt head which mates with a matching elliptical hole in the joint bar. This provides a means of holding the bolt during the tightening operation. These holes are normally alternated in the joint bar so that every other bolt is put through the assembly from the opposite side. This practice makes it extremely unlikely that all the bolts in a joint would be broken during a derailment.

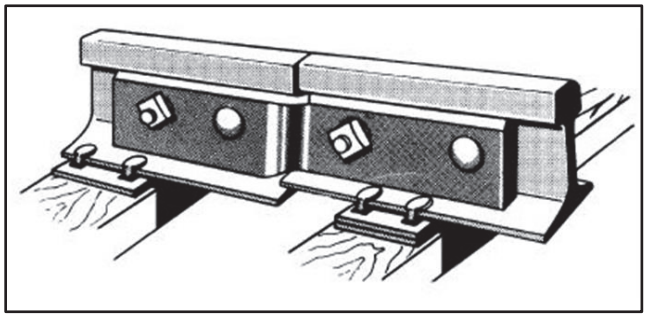


Figure 4-6. Compromise angle bar

SWITCHES

4-21. Switches (figures 4-7 below and figure 4-8 on page 4-8) are mechanical devices consisting of special crossties with rails that permit a train to change tracks and therefore, change direction. Switches may be equipped to operate either manually or electronically.

4-22. Switches have left-hand and right-hand switch points that divert the rolling stock to the proper turnout. Switches also have one or more rods to hold the points in correct relationship to each other and to prevent them from rising. A gauge and switch plates support the switch points at the same elevation as the permanent rail and maintain the correct position of the switch. Clips unite the rods with the switch points and metal guards provide foot protection.

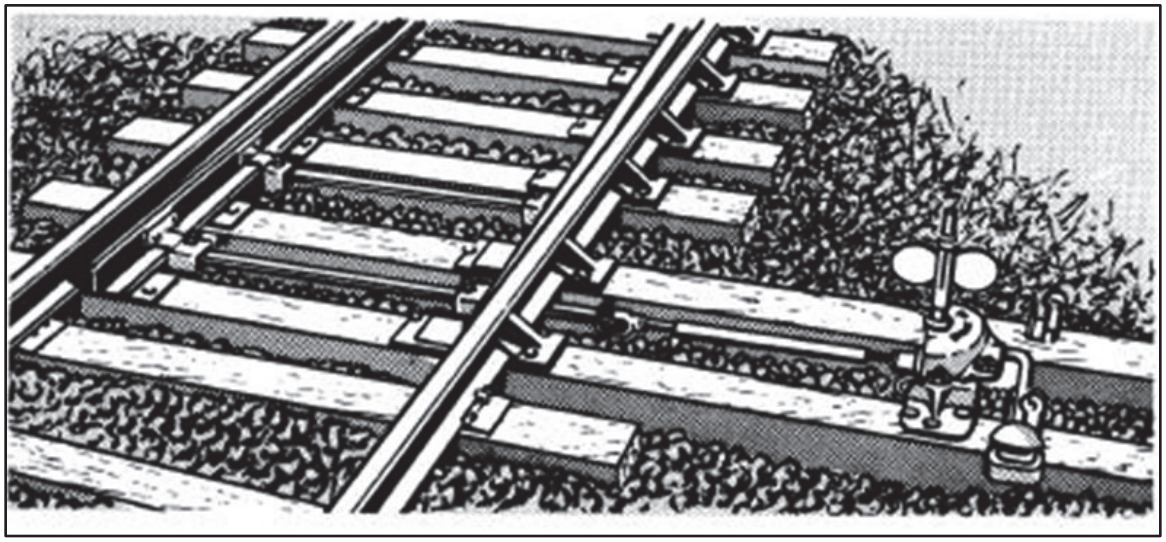


Figure 4-7. Manual switch

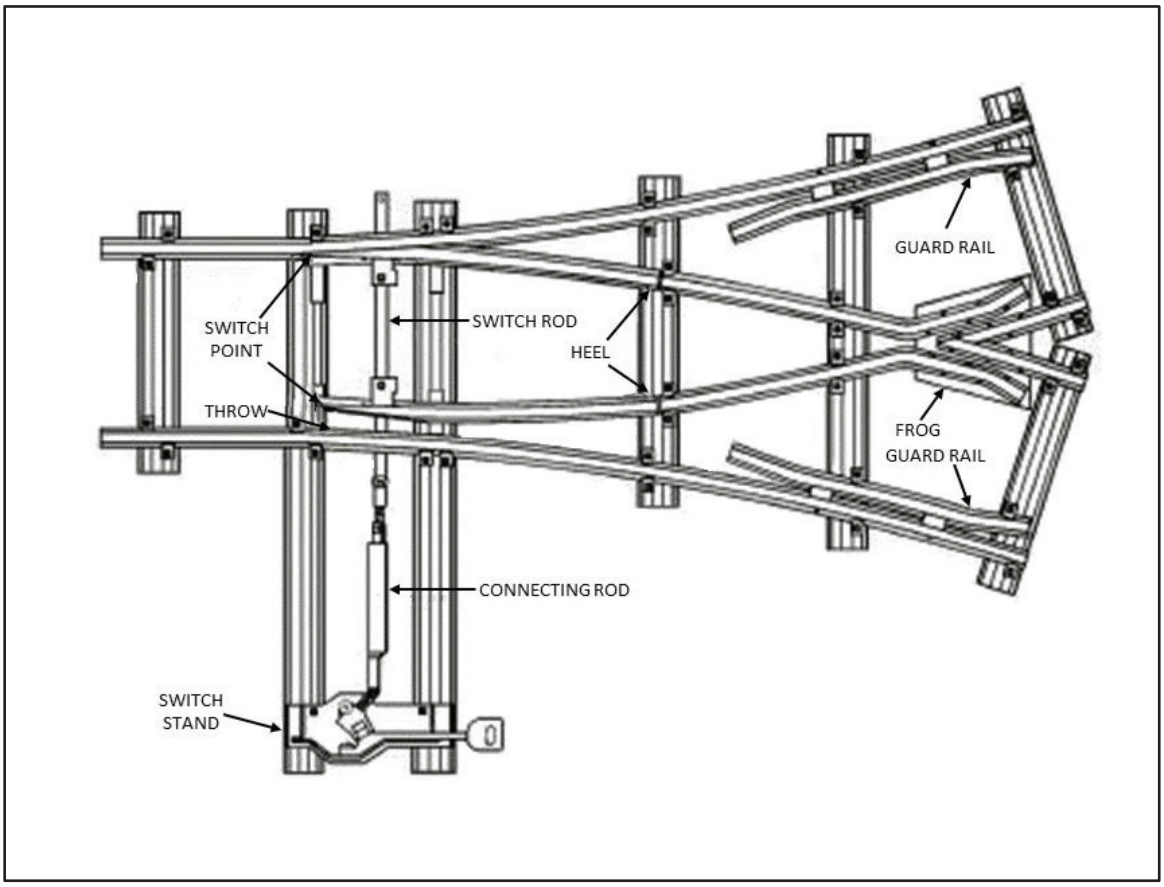


Figure 4-8. Switch components

4-23. A ***switch stand*** **is the mechanism which controls the operation of the switch and shows its position.** (See figure 4-9.)The following are the two types of switch stands:

- Low stands (or ground throw stands). In low stands or ground throw stands, the hand-throwing lever travels in a vertical plane.
- High stands (or column-throw stands). In high stands or column-throw stands, the throwing lever travels in a horizontal plane.

4-24. A switch stand consists essentially of a base, spindle, and throwing lever. These parts are assembled to form mechanisms which, by the use of cranks, gears, yokes, toggles, and other fittings, transmit the circular motion of the throw lever to a switch connecting rod. Therefore, the spindle and its associated mechanism are important parts of the switch assembly. The spindle and its associated mechanism multiplies force applied to the throw lever, delivering maximum force at critical positions in the throw. A switch stand is held in a fixed position, by the anchorage of its base to two ties.

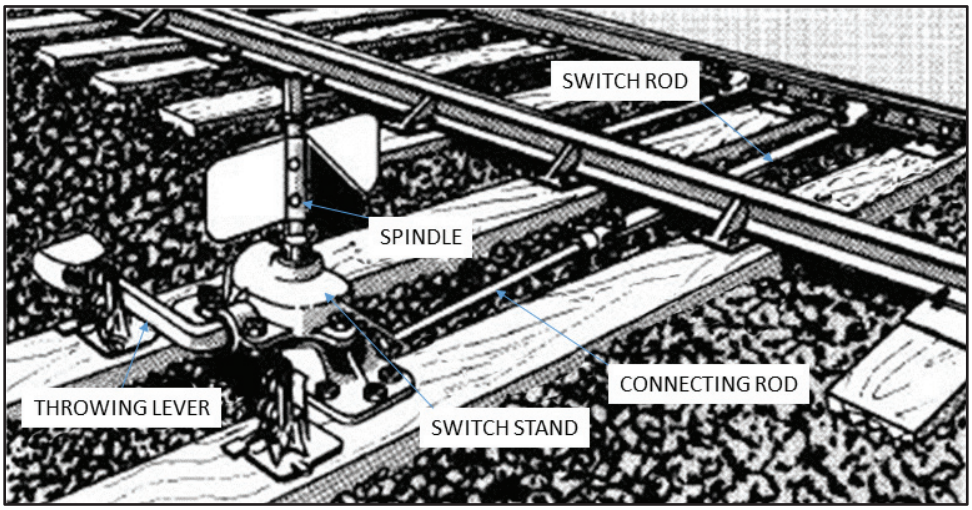


Figure 4-9. Switch stand assembly

DERAILERS

4-25. ***Derailers*** **are safety devices designed to limit unauthorized movement of a car or locomotive beyond a specific point.** (See figure 4-10.) Derailers can be permanent or portable. The most frequent use of derailers is to prevent unauthorized movement of equipment from a side track onto a main track. Derailers are sometimes used to prevent the movement of equipment onto portions of a side track where it might cause an accident or damage.

4-26. Derailers are also used to ensure that rules or signals are obeyed and to protect personnel and equipment against unauthorized, careless, or accidental procedures. If a train passes over an operating derailer, the train will be derailed.

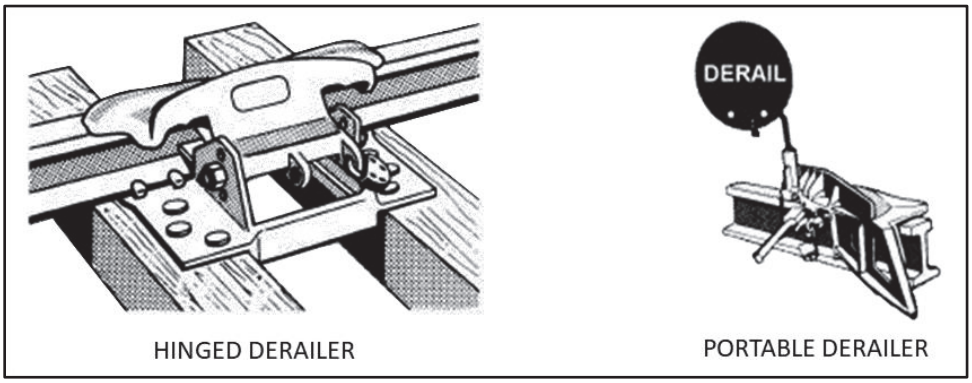


Figure 4-10. Derailers

FROGS AND GUARD RAILS

4-27. Frogs are special pieces of track work that enable flanged wheels to cross from one rail onto another rail. Guard rails consist of a rail or series of rails that lay parallel to the running rails of a track.

Frogs

4-28. Frogs (figure 4-11 on page 4-10) provide continuous channels for the wheel flanges and support the wheels over the intersection. Frogs are built of carbon or heat-treated steel rails, of carbon steel rails combined

with manganese steel casings, and of solid manganese casings. Frogs do not require any mechanical operation.

Guard Rails

4-29. ***Guard rails*** **are a rail or series of rails that lay parallel to the running rails of a track that help prevent derailments by holding wheels in alignment and keeping derailed wheels on the ties.**

4-30. There are three types of guard rails (figure 4-11). Each type is described below.

- Turnout guard rails. These rails are designed and installed to prevent the flanges of the wheels from striking the points of the frogs on turnouts and crossovers.
- Curve guard rails. These rails are applied to sharp curves to guide the flanges of locomotive and car wheels or to support the blind driving wheels of locomotives.
- Bridge guard rails. These rails prevent derailed wheels from running off the ties on a trestle, bridge, or viaduct.

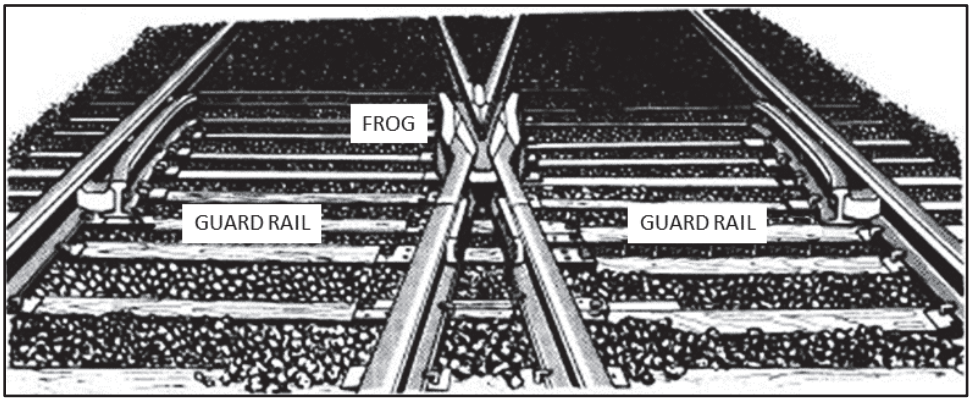


Figure 4-11. Frog and guard rails

TRACK TOOLS

4-31. The mechanization of track maintenance equipment continually progresses in the variety of machines and equipment as well as the functions they perform. However, the basic tools designed for manual use are still required on all railroads. Such tools have a well-defined roll in specific work assignments. For example, mechanized equipment may not always be available to replace a defective rail or deteriorating ties, surface a rough spot, gauge a wide spot in a curve, replace a cracked joint bar, or effect other random maintenance tasks that can be done efficiently with a small work crew. However, there is new equipment currently being used by the railroad industry, which has greatly reduced the size of work crews and increased productivity.

EFFECTS OF TERRAIN ON TRACK, TRACTIVE EFFORT AND MOTIVE POWER

4-32. As previously stated, the ideal railroad would be on entirely flat terrain with no curves, requiring the least tractive effort and motive power to operate on. Unfortunately, this will never be the case. The following paragraphs discuss the realities of track profile, alignment, curves, and ruling grade.

TRACK PROFILE

4-33. ***Track profile*** **is the vertical dimension of the track caused by terrain features such as hills or valleys**. During construction, every attempt is usually made to reduce inclines or grades since they have a direct bearing on the amount of tractive effort, and thus, motive power needed to pull a train. From an operational point of view, when conducting reconnaissance, finding tracks through tunnels bored in mountains may therefore be preferable to finding tracks advancing around or over mountains.

TRACK ALIGNMENT

4-34. ***Track alignment*** **is the horizontal dimension of a track; for example, curves.** Curves are needed to change track direction, whether intentionally (route) or unintentionally (obstacles). Different curves are shown in figure 4-12. The radius of the curve must be as large as possible, as curves apply rolling resistance to train movement. Since a train in motion tends to move in a straight line, it applies a lateral force against curves in the track and increases tractive effort and motive power requirements.

4-35. The alignment of a railroad consists of straight sections (tangents) connected by curved sections. The sharpness of a curve is measured in degrees, minutes, and seconds. Horizontal curves are classified as simple, compound, and reverse. A simple curve is a single arc connecting two tangents. A compound curve is formed by two simple curves of different radii, both curving in the same direction. A reverse curve consists of two curves that bend in opposite directions.

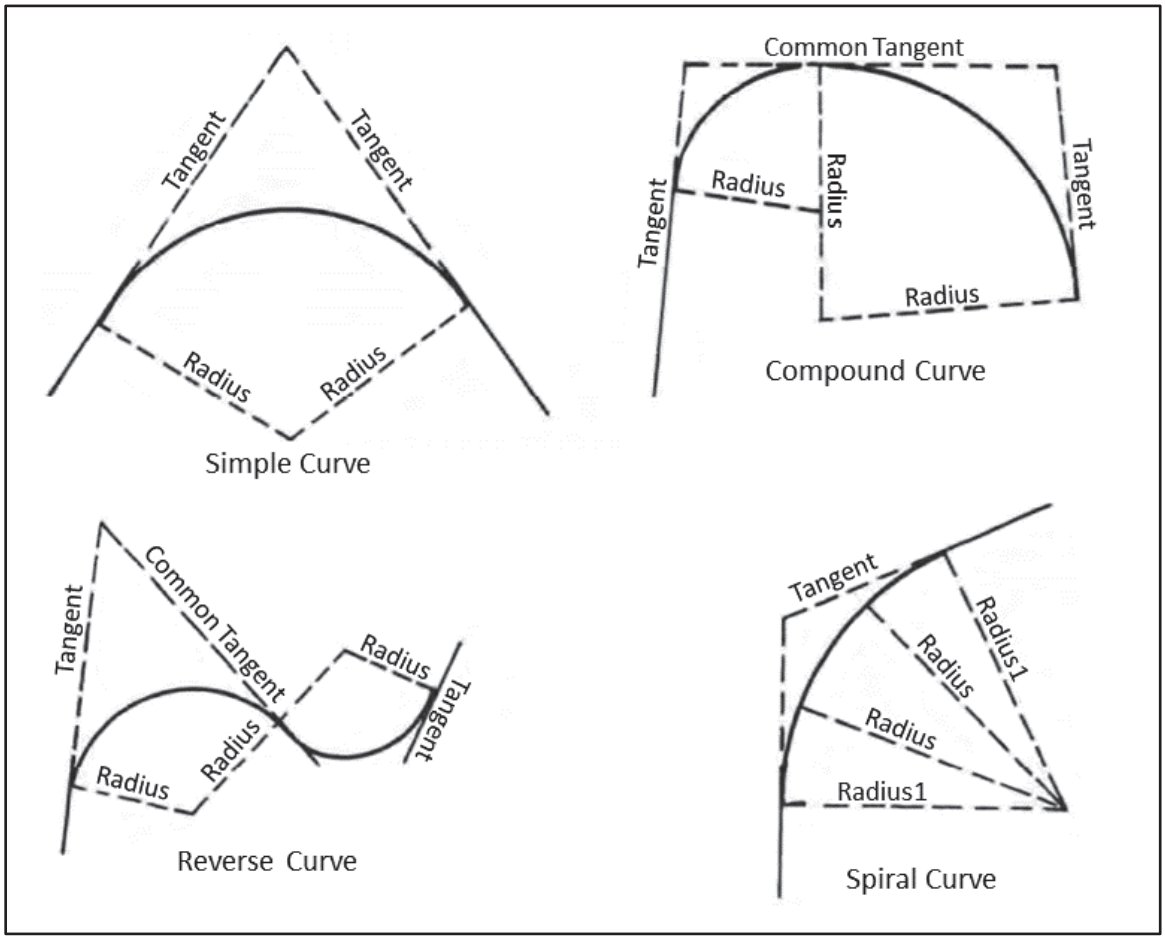


Figure 4-12. Types of horizontal curves

RULING GRADE

4-36. A key factor when calculating motive power requirements for a train is the ruling grade that will be encountered between the starting point and the final destination. The ruling grade calculation considers both track alignment and profile. The steepest grade might not be the ruling grade since another location with a lesser grade, but a tight curve, could cause more rolling resistance. The higher the rolling resistance, the more tractive effort is needed to pull a train. Higher tractive effort for any one train is obtained either by adding more motive power, by either using a more powerful locomotive, or by using two or more locomotives.

4-37. Grade lines are designated by vertical changes within a horizontal distance of 100 feet (30 meters). A grade rising two feet in a horizontal distance of 100 feet is called a + (positive) 2.0-percent grade; one descending the same amount is called a – (negative) 2.0-percent grade. Any grade from 0.0 percent (or level) to 0.4 percent is called light; from 0.4 to 1.0 percent is considered moderate; from 1.0 to 2.0 percent is heavy; above 2.0 percent is very heavy.

DETERMINING CURVATURE

4-38. Use either the survey method or string method to determine curvature. Each of these methods is described below.

Survey Method

4-39. When computing curvature, chord is measured as 100 feet (30 meters). Use the following formula to determine an approximate value for the radius. However, it is possible to obtain an approximate value for the radius from the following simple empirical formula:

$$R = \frac{5{,}730}{D}$$

Where— R = Radius,
D = Degree of curvature
5,730 ft (1,747 m) = approximate length of radius of a l-degree curve
Likewise, D can be computed by: $D = \frac{5{,}730}{R}$

String Method

4-40. Use the string method (figure 4-13) to determine the approximate degree of curvature if a surveying instrument is not available. A portion well within the main body of the curve is selected; a chord distance of 62 feet (18.9 meters) is measured along the inside of the high rail (points A and B). A string or strong chord is stretched tightly between points A and B, and the distance M is measured at the midpoint of the chord. This distance, in inches, is approximately equal to the degree of curvature. As a curve gets sharper, this distance increases. The normal method of horizontal curve layout for railroads uses the string method.

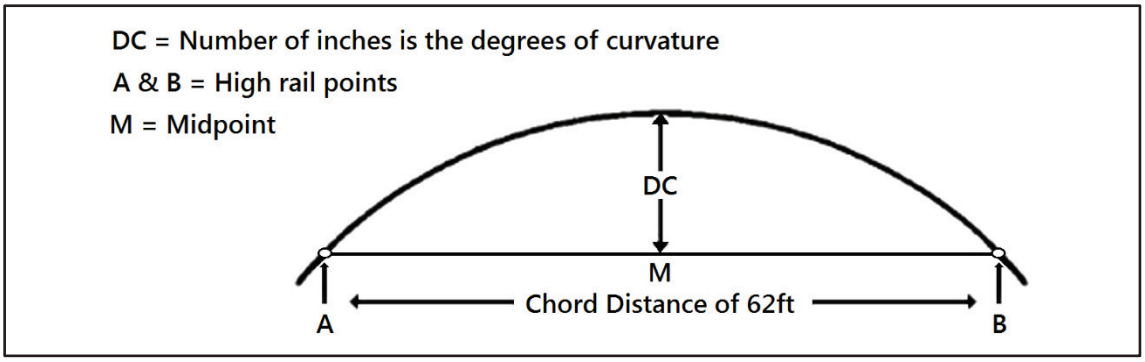


Figure 4-13. String method

STRUCTURES

4-41. Structures can generally be divided into two classes. The two classes are minor structures or major structures. These two classes are described below.

MINOR STRUCTURES

4-42. Minor structures are provided to carry the track over minor natural features (such as small streams and ditches) or over man-made drainage pipelines. These pipes can be of corrugated metal or reinforced concrete. They are generally open-ended and cross under the track at angles varying from 45 degrees to 90 degrees. These structures are vital to the long-term stability of the track and roadbed.

MAJOR STRUCTURES

4-43. Major structures are provided to carry the track over or through major natural or man-made features (such as over rivers or highways or through mountain tunnels). Major structures include bridges, trestles and tunnels.

Bridges

4-44. Bridges are normally constructed from steel, reinforced concrete, masonry, and timber. Two general types of bridges are ballast deck (figure 4-14 on page 4-14) and open deck (figure 4-15 on page 4-14). A ballast deck bridge has a trough-like deck in which a layer of ballast can be laid. The track is constructed on the ballast using standard track construction techniques. The ballast deck bridge is excellent from the standpoint of fire prevention and track maintenance. This type also allows the use of normal track materials and maintenance procedures. An open deck trestle uses the bridge's ties as crossties for the track.

Bridge Capacity

4-45. The design of bridges is to safely carry a specific concentrated load. Loads which may be placed on a structure temporarily or which may be changed in position are termed live loads to distinguish them from fixed, dead, or static loads. Live loads are the tonnage trains, while static loads are the superstructure, tracks, ties, and so forth. The maximum live load consists of two coupled locomotives followed by the number of cars that occupy the entire length of the bridge. Although various formulas have been used to compute bridge capacity, the most accurate of these is Cooper's E rating. In this formula, each driving axle on the locomotive carries a proportionate part of the total weight loaded on the drivers. A bridge designed to carry a 0-6-6-0 diesel-electric locomotive weighing 240,000 pounds (108,844 kilograms) on the drivers, must have a Cooper's rating of at least E-40 (40 equals to 40,000 pounds). A 0-6-6-0 locomotive has six driving axles. The following is the formula for computing the E rating of the locomotive.

240,000 pounds = 40,000 pounds 6 (driving axles)

or

108,844 kilograms = 18,144 kilograms 6 (driving axles) = the amount each axle can carry

4-46. If the gross weight of a car in the train exceeds the weight of the locomotive pulling the train, the Cooper's E rating must be computed based on the gross weight of that car. The E rating must be for the heaviest piece of rolling stock in the train.

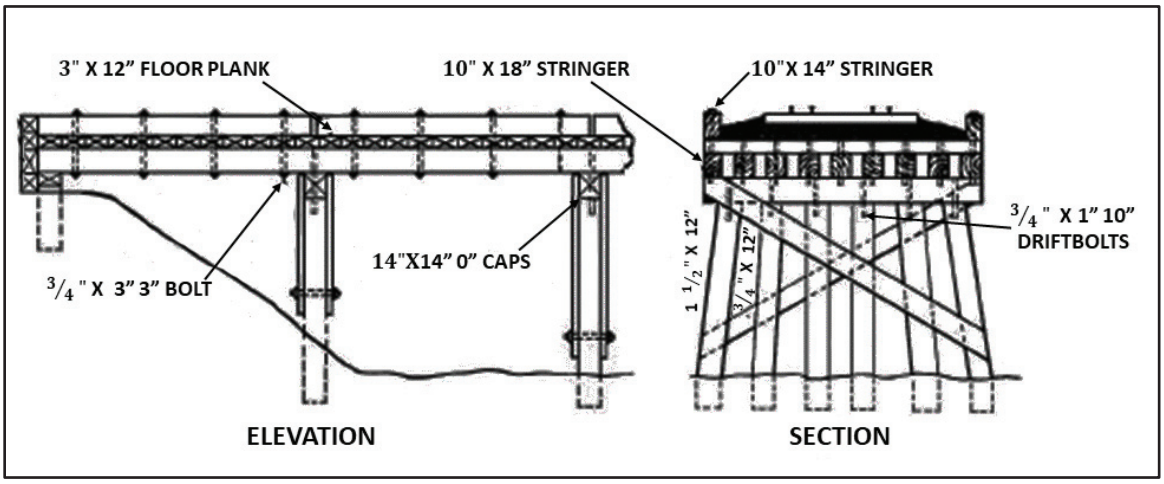


Figure 4-14. Ballast deck bridge

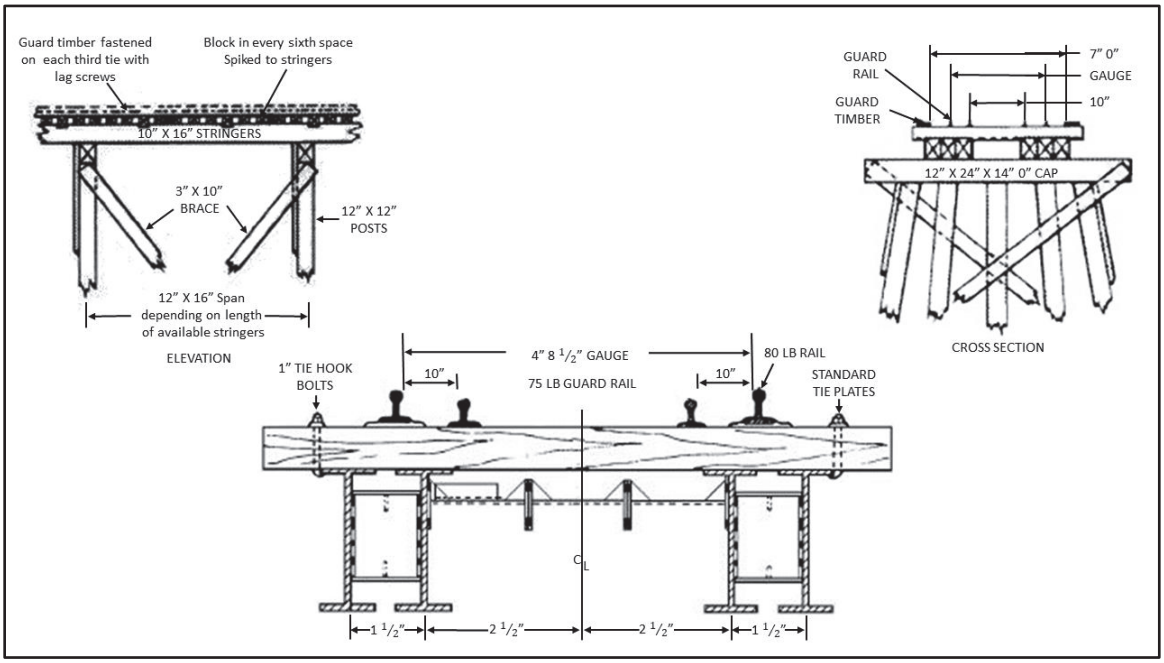


Figure 4-15. Open deck bridge

Steel And Wooden Stringer Bridges

4-47. There is usually an economical consistency in the design of all parts of a railroad bridge. Dimensions of the floor system are related to the load for which the whole structure was designed. Table 4-1 and table 4-2 starting on page 4-16 show the Cooper's E rating of a number of typical railroad bridges and the stringer dimensions of their floor systems.

4-48. To estimate the capacity of a railroad bridge with steel stringers or girders as part of the floor system, the width and thickness of the lower flange of the stringer are measured (see figure 4-16 on page 4-17). The depth and the length of the stringer are also measured. The corresponding E rating of the bridge is then determined.

4-49. To estimate the capacity of a railroad bridge with wooden stringers as part of the floor system, the width of each stringer under one track is measured (see figure 4-17 on page 4-17). The widths of all the

stringers are then added together to attain the total. The depth and length of one stringer also are measured. The wooden stringer is selected that most nearly approximates these dimensions and the corresponding E rating of the bridge is determined.

Table 4-1. Determination of bridge capacity (steel I-beam construction)(Cooper's E rating)

Stringer Dimensions (inches)			***Span Length (feet)***											
Thickness	***Width***	***Depth***	***10***	***11***	***12***	***13***	***14***	***15***	***16***	***17***	***18***	***19***	***20***	***22***
3/8	8 3/8	18	E-42	E-41	E-41	E-41								
3/8	10 3/8	24		E-59	E-48	E-40	E-35	E-31	E-27					
½	10 3/8	30				E-61	E-59	E-51	E-46	E-41	E-37	E-33	E-30	E-27
½	12 ½	30						E-62	E-56	E-50	E-45	E-41	E-37	E-31
1	14	36								E-60	E-58	E-55	E-54	E-51
½	12 3/8	42										E-60	E-54	E-45
1 1/8	14	42											E-63	E-60
Stringer Dimensions (inches)			***Span Length (feet)***											
Thickness	***Width***	***Depth***	***24***	***26***	***28***	***30***	***35***	***40***	***44***	***50***	***54***	***60***	***64***	
1/2	12 ½	30	E-26											
1	14	36	E-48	E-43	E-39	E-34	E-26							
1/2	12 3/8	42	E-39	E-34	E-30	E-26								
1 1/8	14	42	E-57	E-54	E-51	E-45								
1 1/8	16	42			E-60	E-54	E-42	E-32						
1 1/2	16	48				E-59	E-52	E-47	E-43	E-33				
1					E-66	E-57	E-45	E-35	E-30					
1 5/8	14	54					E-54	E-43	E-36	E-28				
1 3/4	14	60						E-60	E-54	E-43	E-37	E-30	E-27	
Stringer Dimensions (inches)			***Span Length (feet)***											
Thickness	***Width***	***Depth***	***40***	***44***	***50***	***54***	***60***	***64***	***70***	***74***	***80***	***84***	***90***	
1 1/2	14	60	E-57	E-48	E-38	E-33	E-27							
2 1/8	15	66			E-57	E-54	E-46	E-41	E-34	E-31	E-26			
2	14	66			E-56	E-48	E-40	E-35	E-30	E-26				
2	14	72			E-62	E-54	E-44	E-39	E-32	E-29	E-25			
2 1/2	15 ½	72					E-55	E-51	E-43	E-38	E-33	E-29		

Table 4-1. Determination of bridge capacity (steel I-beam construction)(Cooper's E rating) *(Continued)*

Stringer Dimensions (inches)			*Span Length (feet)*											
Thickness	***Width***	***Depth***	***10***	***11***	***12***	***13***	***14***	***15***	***16***	***17***	***18***	***19***	***20***	***22***
2 1/8	14	78				E-64	E-52	E-46	E-39	E-35	E-30			
2 1/2	16	84						E-64	E-54	E-49	E-41	E-38	E-30	
2 11/16	20	96										E-59	E-51	

Table 4-2. Determination of bridge capacity (wood beam construction) (Cooper's E rating)

Stringer Dimensions (inches)		*Span Length (feet)*						
Thickness	***Width***	***10***	***12***	***14***	***16***	***18***	***20***	***22***
18	12	E-16	E-12					
18	14	E-22	E-18	E-10				
18	16	E-28	E-20	E-15	E-10			
18	18	E-38	E-26	E-18	E-14	E-12		
20	12	E-18	E-12					
20	14	E-25	E-17	E-12				
20	16	E-33	E-23	E-16	E-12	E-10		
20	18	E-43	E-29	E-21	E-16	E-13	E-10	
24	12	E-22	E-15	E-11				
24	14	E-30	E-21	E-14	E-11			
24	16	E-40	E-28	E-20	E-15	E-12		
24	18	E-52	E-36	E-25	E-19	E-15	E-12	E-10
36	12	E-34	E-23	E-17	E-12	E-10		
36	14	E-47	E-32	E-23	E-17	E-14	E-11	
36	16	E-62	E-43	E-30	E-23	E-19	E-15	
36	18	E-78	E-53	E-30	E-30	E-24	E-20	E-16
40	12	E-38	E-26	E-19	E-14	E-11		
40	14	E-52	E-36	E-26	E-20	E-16	E-12	
40	16	E-69	E-47	E-35	E-26	E-21	E-17	E-17
40	18	E-87	E-60	E-44	E-34	E-27	E-22	E-18
48	12	E-46	E-31	E-23	E-17	E-13		
48	14	E-63	E-43	E-31	E-24	E-19	E-15	
48	16	E-69	E-47	E-35	E-26	E-21	E-17	E-17
48	18	E-105	E-73	E-53	E-41	E-33	E-27	E-22
54	12	E-52	E-35	E-27	E-19	E-15		
54	14	E-72	E-49	E-35	E-22	E-18		
54	16	E-94	E-65	E-46	E-36	E-29	E-24	
54	18	E-119	E-42	E-60	E-46	E-38	E-30	E-25
60	12	E-58	E-40	E-30	E-22	E-17		
60	14	E-79	E-55	E-39	E-30	E-35	E-20	
60	16	E-104	E-72	E-52	E-40	E-33	E-27	
60	18	E-132	E-92	E-67	E-52	E-42	E-34	E-28

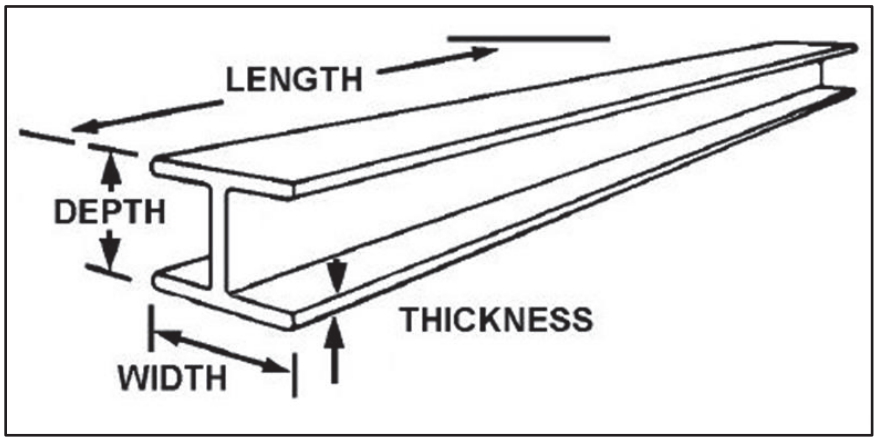


Figure 4-16. Dimensions of a steel stringer

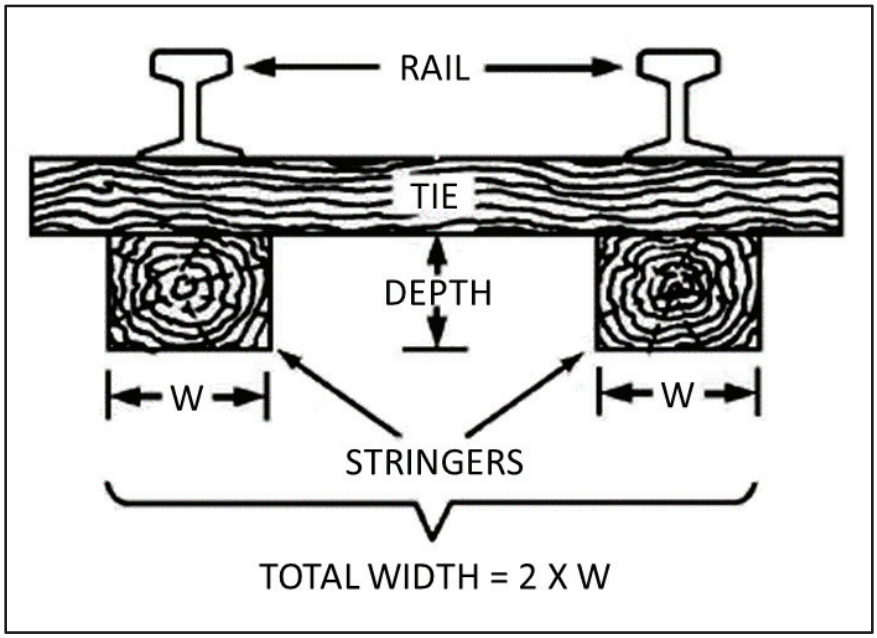


Figure 4-17. Dimensions of a wooden stringer

Tunnels

4-50. Two principal types of tunnels are lined and unlined. Lined tunnels are cut through unconsolidated formations. A lining is provided to prevent cave-in on these types of tunnels. These linings are usually formed from concrete or timber. Unlined tunnels are cut through solid rock formations. The rock walls and ceiling that remain, form the exposed surfaces of the tunnel.

EFFECTS OF COLD WEATHER

4-51. Cold weather conditions can impose a considerable burden on the operation and maintenance of railway service. Cold weather can affect yard switching, making it slow and difficult. It also has an effect on starting trains and making steel car parts brittle. Heavy winds (common in cold weather) can also hamper operations on the road and in the yards.

TRACK AND ROADBED

4-52. In cold climates, having a terrain similar to that of Alaska, the elements may cause damage to the track and roadbed. Areas of this type are underlaid with permafrost through which surface water cannot penetrate and which drains off in the summer. During thaws, the water lies on top of the ground, often partially covering the ties. This can cause tie rot and disturbs alignment, surface, and gauge. In winter, the water freezes and heaves the track dangerously out of line. Maintenance must be done on the track and roadbed as soon as the weather permits.

BRIDGES

4-53. Frost-heaving causes extensive maintenance repair to be made on bridges and trestles constructed of wood pilings. These repairs may reduce division TD. Maintenance problems occur when water below the ground surface freezes, therefore causing the piling to rise. This in turn may raise the level of a bridge two or three inches higher than the normal level of the track. There is no known way to combat this condition except by removing the decking, track, and ties, cutting off the tops of the piling to a suitable height, and then replacing the top structure.

POLE LINES

4-54. In some areas it may be impossible to use utility poles in the conventional manner. In warm weather, the soil in low spots becomes so unstable that the poles cannot be kept vertical. In winter, the poles may be heaved up by frost and the wires will break. Wires should never be too taut between poles because winter contraction may cause them to break. Using poles built in a tripod shape with a wide base that rests on the ground will help stabilize the poles. Nothing can be done about wires that break due to heavy ice covering. An adequate supply of wire and splicing materials and maintenance personnel must be available to keep communication functions open during the winter.

TUNNELS

4-55. Tunnels are usually a simple maintenance problem. However, in cold climates, water seepage can cause extreme difficulties. Ice can form on the track, which often makes the tunnel impassable. There is hardly any way to bypass tunnels. In summer, the frozen earth under the track heaves to the extent that train movements may often be suspended. Work inside tunnels is slow and difficult because of the confined space in which men and machinery must work. In some areas, much of the difficulty has been overcome by steam heating some of the tunnels and putting doors on the portals. Workmen can be assigned throughout the winter as firemen and door tenders to keep the tunnels warm and to open and close the tunnel doors for train passage. The tunnels are therefore kept at a temperature above freezing, and the water that seeps through the walls and ceiling is drained to the outside.

TRACK OBSTRUCTIONS

4-56. There are some obstructions that are either unforeseen or uncontrollable. Some of these are discussed below.

Snowfalls

4-57. Heavy and frequent snowfalls require the constant use of snowplows. During heavy snows, a locomotive with a plow may have to precede each main line train. At times, the snowfall may be so heavy that two trains may have to remain in sight of each other. It may be practical to equip locomotives with a small blade permanently attached to their pilots. Alaskan railroads have successfully used a notch blade that can be lowered a couple of inches below rail level. This is an expedient, which is only effective against snow a few inches deep. A snowplow, pushed by one or more locomotives, is usually needed to clear overnight snowfalls or even snowfalls of a few hours duration.

Earth and Rock Slides

4-58. Slides are a frequent source of trouble in a hilly, cold climate. They occur in deep cuts, along steep slopes, and frequently at the mouths of tunnels when frozen hillsides or mountainsides thaw in the spring. In Alaska, and similar climatic and topographical areas, the summer shifting of glacial mountains is a problem. Glacial mountains move several feet each year over a lineal distance of several hundred yards. When a rail line runs alongside a glacial mountain, the affected right-of-way may have to be rebuilt. However, there is little that can be done if moving the track is not feasible. Prudent planning includes storing materials, tools, and supplies where they are in no danger of being covered by slides. Snow slides also present a serious problem in heavy snow climates. Such slides are generally heavier in weight and greater in volume than in temperate climate areas. Off-track machinery is not practical in cleanup operations because roads to reach such areas are usually nonexistent. The extreme cold also hampers workmen. The use of high-speed rotary snowplows in cleaning such slides is usually impossible because of the debris (for example; dirt, rocks, and twigs) that may come in contact with its high-speed blades.

Wild Animals

4-59. The presence of wild animals on the track may cause temporary track obstructions and account for major delays to freight and passenger trains. Animals may get on snow-cleared tracks and remain there to escape the deep snow and because they have more of a chance to fight off other animals. All reasonable efforts must be made to clear animals unharmed from the track. For example, many moose have been killed on railroad tracks in Alaska, and trains running squarely over moose have been derailed. There are recorded cases where moose walked ahead of trains for 15 miles before leaving the track. During the rutting season, the bulls are extremely excitable and often charge a moving train. Railroad personnel working under such conditions must exercise care.

EFFECTS OF HOT WEATHER

4-60. Cold weather is not the only cause for concern on a rail line. Hot weather brings with it its own set of potential problems. The most serious being sun kinks. A sun kink is the twisting, bulging, buckling, or otherwise warping of steel railroad tracks in high temperatures. Sun kinks are an especially big concern on sections of track where the rails are welded together to form long, continuous stretches with no joints. This lack of joints offers no extra space to accommodate the expansion of the steel rail when high temperatures occur. Rails began being welded together in the 1950s to make for a smoother ride and reduce maintenance costs. However, sun kinks and subsequent rail accidents were an unforeseen complication to the practice.

4-61. Countermeasures to prevent sun kinks include heating rails to condition them to high temperature spikes. In the U.S., commercial tracks are typically heated up to 100 degrees in the South, and 90 degrees in the North. Improvement in track-laying technology and the use of stronger alloys that are less susceptible to temperature extremes have also lessened the severity of sun kinks, though the problem has not gone away entirely. How the tracks are installed can also make a big difference. Track should be installed at a temperature that will accommodate the expansion and contraction caused by weather fluctuations.

4-62. The best preventive measures for accidents as a result of sun kinks are inspection and maintenance. On particularly hot days, crews should be sent out ahead of large trains to search for sun kinks and make track adjustments if necessary and possible. Another good safety rule would be to slow down trains across the board when temperatures spike.

SUMMARY

4-63. One of the primary missions of ERC personnel is to deploy and conduct an initial reconnaissance and assessment of a HN's rail infrastructure. In order to do this, they must understand several aspects of railway structure and construction. The track is the most valuable, important, and vulnerable part of a railway system. It consists of many components the team conducting the assessment must understand. The team must also pay close attention to the local terrain because it will have an effect on the track's profile and alignment. In all railway systems, there are major structures, such as bridges and tunnels, as well as minor structures that carry the track over minor natural and man-made features. Each and every one of these structures must also be assessed in great detail. Additionally, weather can have a dramatic effect on rail operations. With cold

weather comes situations like snow and ice making sections of track impassable, and frost heaving that could severely damage track. With hot weather comes sun kinks and severely damaged rail. The assessment team must take all variables into account during their reconnaissance.

Chapter 5

Railway Equipment

Chapter 4 described railway structure and the ERC's responsibility to conduct a detailed reconnaissance and analysis of a HN's trackage and rail facilities in an effort to modify the broad-based initial plan as necessary. The next step would be for the ERC to conduct that same analysis of the HN's railway equipment. This chapter describes the different kinds of railway equipment that exists in the U.S., and the equipment that ERC personnel are likely to encounter around the world. Equipment needs to be utilized in an effective manner, in order to efficiently support a military operation in theater.

PLANNING CONSIDERATIONS

5-1. In the past, the Army owned a wide variety of rolling stock, including locomotive cranes, tank cars, freight cars of miscellaneous types, and numerous diesel-electric locomotives. Most of the larger locomotives were designed for foreign and domestic service and were equipped with multi-gauge trucks, which could be adjusted to any gauge from 56 1/2 to 66 inches. Today, the ERC maintains no rail equipment and HN rolling stocks must be relied upon to accomplish the mission.

5-2. ERC personnel must keep in mind that many countries in potential areas of unrest are served by narrow-gauge railroads. Equipment in these areas is often in poor condition. The locomotives and freight cars may be old and in need of repair. Locomotives may have low tractive effort and cars may only consist of boxcars and a few flatcars with low carrying capacities. The ideal situation for the combatant commander would be to utilize fast-moving, high-density trains on HN rail lines in order to move a high volume of military tonnage. However, this may not be possible. It is the ERC's mission to develop a good plan, do the best they can, utilizing what they have, and recommend that plan to the commander.

TYPES OF RAILWAY EQUIPMENT

5-3. The three basic types of railway equipment (both in domestic and foreign railroads) are passenger, freight, and special. Each type of equipment is discussed below.

PASSENGER EQUIPMENT

5-4. Passenger equipment is frequently limited to use in troop movements, leave trains, military casual personnel trains, and trains for patient movement. There are several different types of passenger cars, each designed for a special purpose. Examples are coach cars, sleeper cars, baggage cars, and dining cars. If cars are required for patient movement in a theater of operations, passenger equipment may be converted for use as casualty evacuation cars and are moved in designated trains.

FREIGHT EQUIPMENT

5-5. Freight equipment is used primarily for the movement of general cargo. The commodity to be moved dictates the type of freight car that will be used. Table 5-1 on page 5-2, lists examples of the most common freight equipment. Freight equipment, both domestic and foreign, is shown in figure 5-1 on page 5-2 and figure 5-2 on page 5-3. Table 5-2 on page 5-3, lists freight equipment (by category) used in Europe.

Table 5-1. Examples of railway equipment

Type	*Commodity*	*Examples*
Boxcar	Bulk items that need protection from the weather and/or theft	paper, electronic equipment, medical supplies
Flatcar	Bulk items where protection from the environment is not a factor. Also items that will not fit in other freight cars	vehicles, containers, oversize loads
Gondola car	Bulk items where protection from the environment is not a factor. The sides of the car help keep the load from shifting	containers, field barrier materials, scrap metal
Hopper car (covered hopper)	Free-flowing solids that need protection from the environment	gravel, coal, sand, grain, chemicals
Tank car	Bulk liquids	Petroleum products, chemicals, water
Refrigerator car	Items that need a constant temperature, either cool in a warm environment or vice versa	food perishables, medical supplies

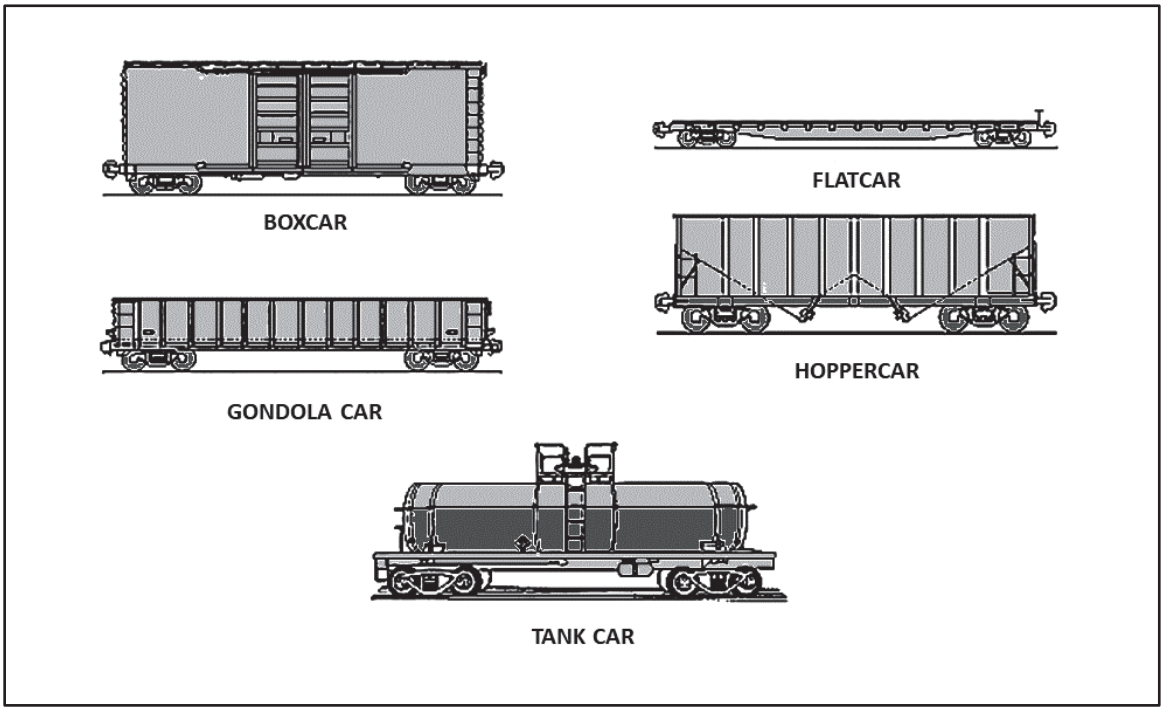


Figure 5-1. Freight equipment (domestic)

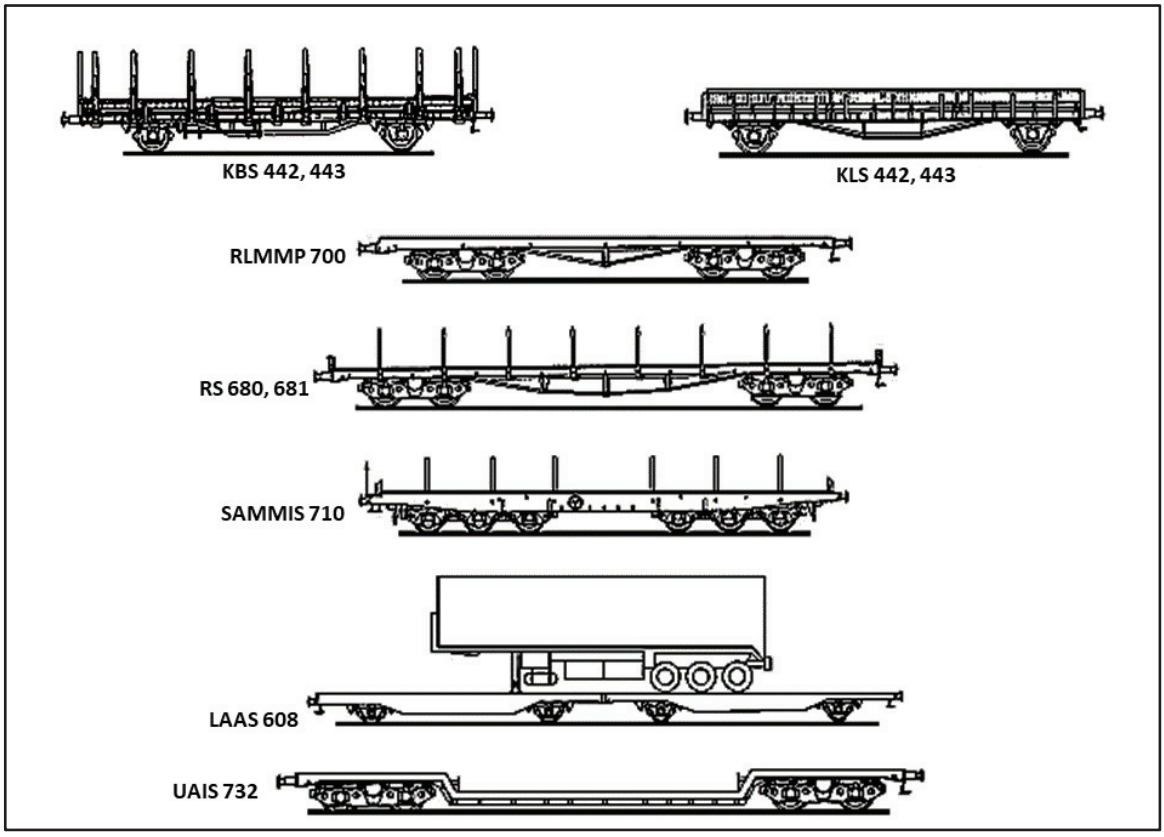


Figure 5-2. Freight equipment (foreign service)

Table 5-2. Examples of foreign flatcars

Type	*Number of Axles*	*Maximum Loading Specifications*			*Remarks*
		Length (meters)	*Width (meters)*	*Weight (meters)*	
Light-duty flatcars:					
KBS 442, 443	2	12.50	2.77	27	With stakes, removable side and end walls.
KLS 442, 443	2	12.50	2.77	27	With removable side and end walls.
Heavy-duty flatcars:					
RLMMP700	4	9.50	3.15	52	
RS 680	4	18.50	2.74	56	
RS 681	4	18.50	2.78	56	
SAMMS 710	6	15.00	3.11	65	End jacks provide stability during loading and off-loading.
Special Flatcars:					
LAAS 608	4	9.00 per section	2.50	54	A short-coupled unit comprised of two 2-axle flatcar sections.
Uais 732	4	10.00	2.50	50	Deep-well cars are available in various sizes, but are few in number and are in high demand.

SPECIAL EQUIPMENT

5-6. Special equipment consists of locomotives, wreck cranes, and snowplows. Figure 5-3 shows the special equipment used in domestic and foreign service.

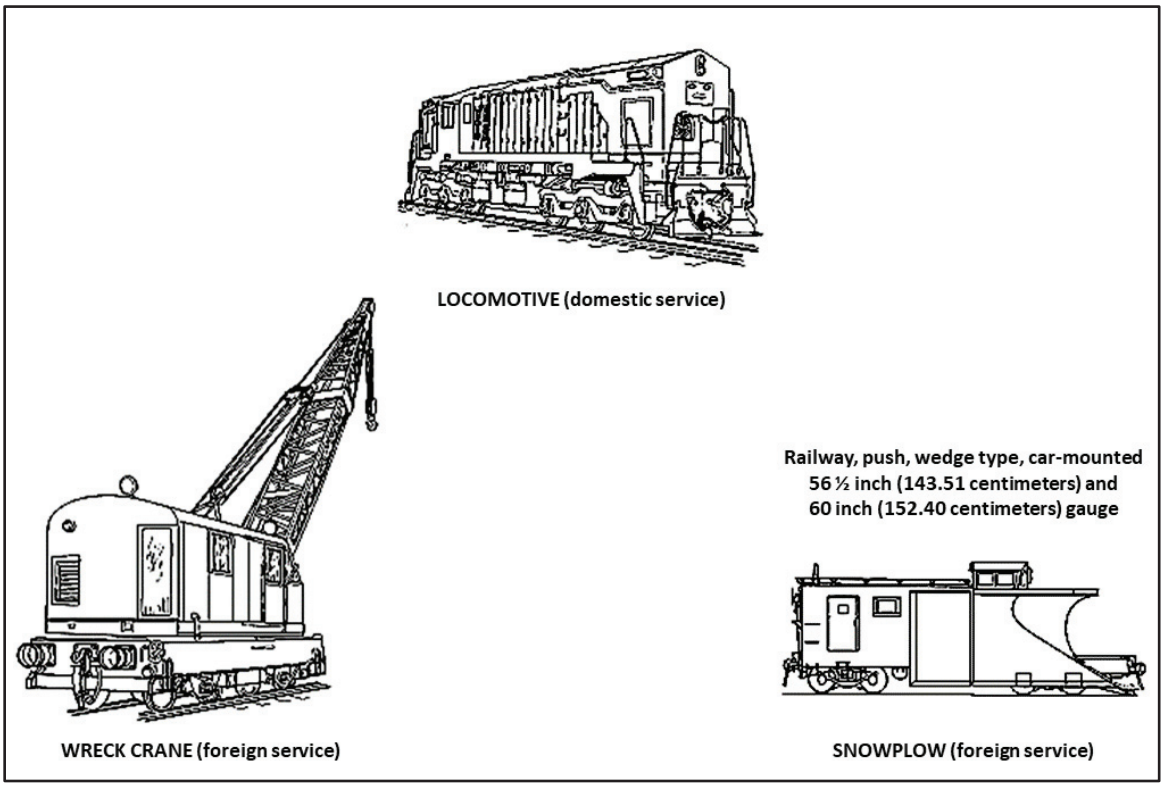


Figure 5-3. Special equipment (domestic and foreign service)

CAR COMPONENTS

Transporters must have a basic knowledge of car components. Those in rail operations must have a thorough knowledge of car components. The four main components of a freight car are the deck, underframe, truck, and coupler.

Deck

5-7. The ***deck*** **is the surface of a railcar on which the load rests.** The deck or floor is usually steel or wood.

Underframe

5-8. The ***underframe*** **is the structure of a railcar under the deck that supports the weight of the load.** Figure 5-4 shows the topside and underside views of the underframe.

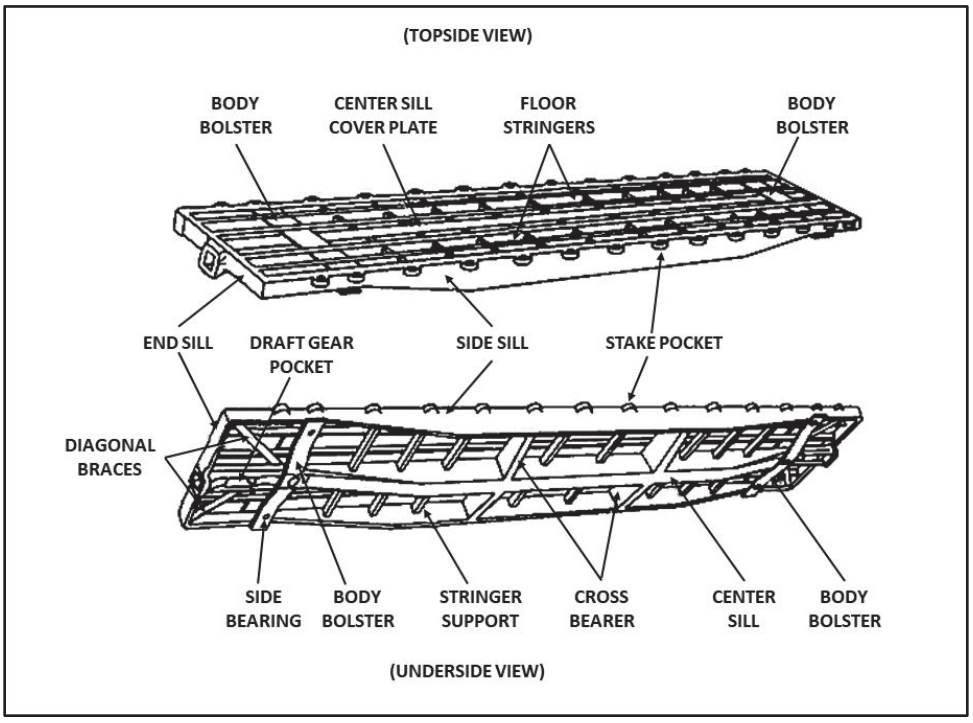


Figure 5-4. Underframe

Truck

5-9. The truck is that assembly which contains a car's wheels, axles, journals, suspension system, and brake system. Figure 5-5, shows all the components of the truck.

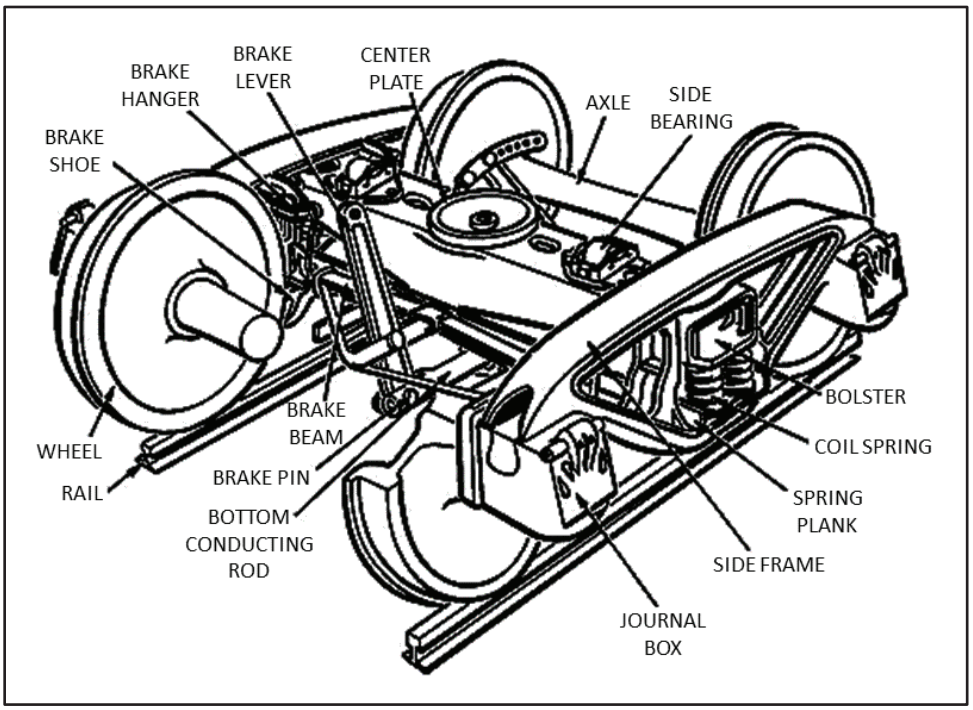


Figure 5-5. Truck coupler

Coupler

5-10. The coupler (figure 5-6) is a device which connects or couples a car with another car. An automatic or knuckle coupler is used in the continental U.S. and in military railroading. The hook-and-link system is used in Europe. The automatic coupler has two advantages over the hook-and-link system. The automatic coupler is stronger (allowing for heavier trains) and it is also safer. The automatic coupler does not require a trainman to step between the cars to couple them, but a hook-and-link coupler does.

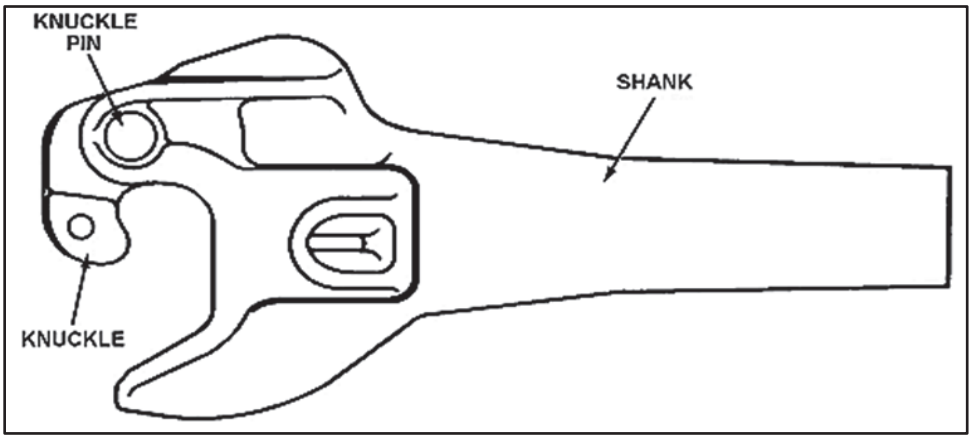


Figure 5-6. Automatic coupler

LOCOMOTIVE CLASSIFICATION

5-11. Locomotives are classified according to wheel arrangement. The two systems used are the Whyte and the Continental.

WHYTE SYSTEM

5-12. The Whyte system is a steam and diesel-electric locomotive classification system that groups wheels and uses numerals separated by hyphens to represent the number of wheels in each group. This system is generally accepted in Great Britain, the British Commonwealth, and in North and South America. Locomotive wheels are grouped as leading, driving, and trailing wheels. Numerals are then separated by hyphens represent the number of wheels in each group, starting at the front end of the locomotive. The first figure represents the number of leading wheels, the second represents the number of driving wheels, and the third the number of trailing wheels. Use the figure "0" if there are no leading or trailing wheels. Tender wheels are not included. The weight distribution of a diesel-electric locomotive is different from that of a steam locomotive. This is because the diesel has no tender, leading trucks, or trailing trucks. The locomotive's weight is evenly distributed on the driving wheels.

5-13. The wheel arrangements of two locomotives using the Whyte system are shown in figure 5-7. Since the wheel arrangement represents a side view of the locomotive, only one wheel of each pair is shown. The 2-8-0 steam locomotive shown has two leading wheels, eight coupled driving wheels, and no trailing wheels. The 0-6-6-0 diesel-electric locomotive shown has six driving wheels on the front truck assembly, six on the rear truck assembly, and no leading or trailing wheels. The pulling capacity of a locomotive is directly related to the number of driving wheels (drivers) and the amount of weight that rests on them.

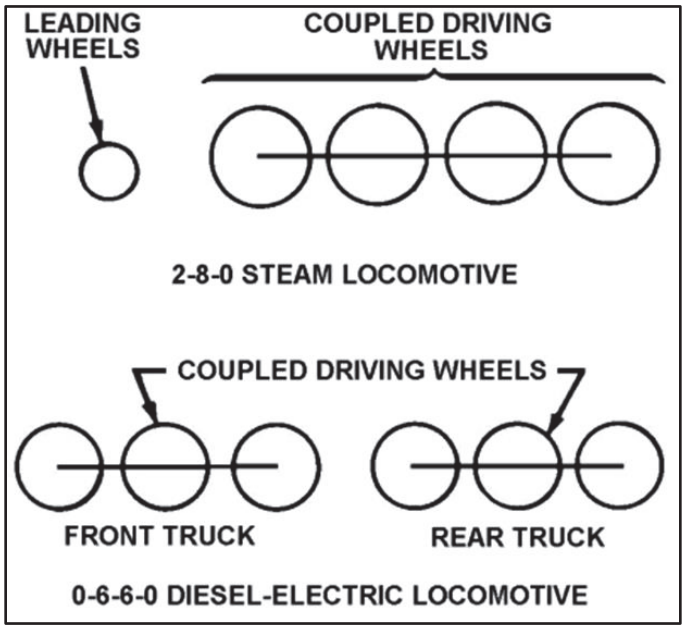


Figure 5-7. Whyte system of wheel arrangement (two locomotives)

5-14. The amount of a locomotive's weight that rests on its drivers is expressed in pounds or short tons (STON) of 2,000 pounds each. The distribution of weight on drivers differs between steam and diesel-electric locomotives. This is important when computing tractive effort. The weight distribution of a 2-8-0 steam locomotive and tender is shown in figure 5-8. The locomotive and tender weigh 296,350 pounds, but only that portion of the total weight that rests on the driving wheels (141,500 pounds) affects the work capacity or pulling power of the locomotive. On a diesel- locomotive, the weight of the locomotive is evenly distributed over all the wheels since all wheels are driving wheels.

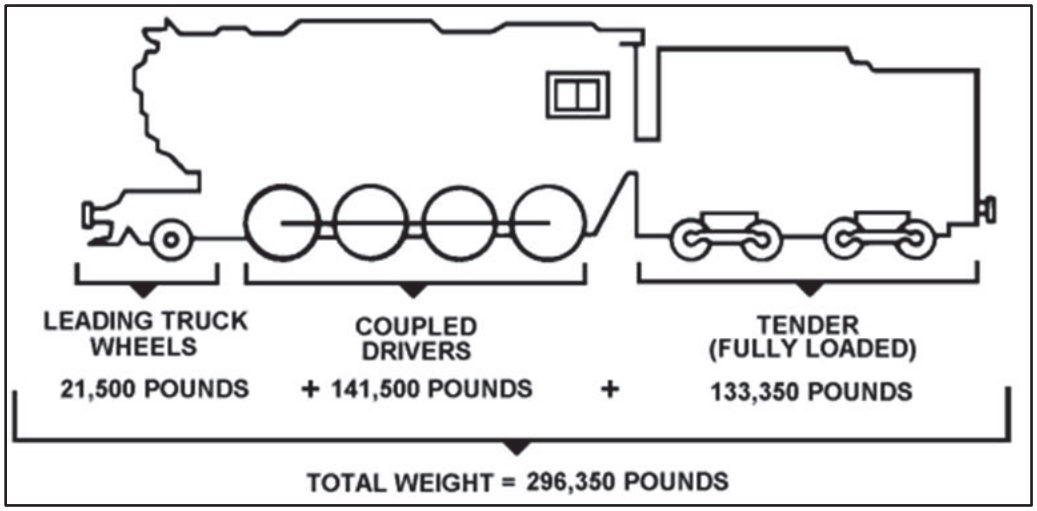


Figure 5-8. Weight distribution of a 2-8-0 steam locomotive

CONTINENTAL SYSTEM

5-15. The continental system is a diesel or electric locomotive classification system that uses letters and figures to identify them by their axels**.** It is commonly used in Europe and other parts of the world. Letters are used for driving axles and numbers are used for non-driving axles. In this system, "A" stands for one

driving axle, "B" for two, "C" for three, and “D" for four. A small "o" placed after the initial letters shows that each axle is individually powered. Therefore, a single unit locomotive with two individually powered two-axle trucks would be classified as Bo-Bo. One with three axle trucks in which the center axle is an idler would be designated as A1A-A1A.

EFFECTS OF COLD WEATHER ON MOTIVE POWER AND ROLLING STOCK

5-16. In the past, steam locomotives were used successfully by all railroads operating in cold climates. Most of the world’s railroads have adopted the diesel because it offers certain advantages over the steamers. However, there are certain modifications that must be made to both types of locomotives before they are entirely suitable for extremely cold weather operations.

STEAM LOCOMOTIVES

5-17. Efficient steam locomotive operation depends on a local supply of fuel, water, and sanding facilities at suitable points along the line. Coal platforms are constructed with their beds level with the top of tenders. Such platforms have been used without any great difficulty resulting from cold temperatures. Water tanks must be kept heated all winter. This is done with steam pipes, which encircle the interior of the tank. In any climate having winter temperatures as low as 40 degrees Fahrenheit, sand for wheels must be thoroughly dried.

INSULATION

5-18. Personnel will insulate exposed water pipes to keep them from freezing and exposed steam pipes to prevent heat loss. Locomotive cabs are especially insulated. Cover windows at night with blankets, on steam heated passenger cars, to keep out the extreme cold.

STANDBY SERVICE

5-19. When steam locomotives are used, engine watchers must be provided. The watchers must fire up the engines to keep up pressure and must put water in the boilers. When first moving a steam locomotive, the cylinder cocks must always be opened to relieve the cylinders of extremely heavy condensation. In average winter climates, one watcher may tend as many as ten locomotives. In cold climates, the number of locomotives for each man must be reduced because of the greater variety of duties. These duties consist of continual operation and checking of the following:

- Stokers.
- Boiler blowoffs.
- Injectors.
- Cylinder cocks.
- Lubricators.

5-20. Reverse levers (particularly screw-reverse types) have to be operated frequently to protect against freezing. Any water leaking on parts that move must be corrected at once to prevent ice from forming. Placing locomotives inside heated roundhouses or enginehouses (facilities that contain repair equipment, materials, and tools used to inspect, service, and make running repairs on locomotives) will substantially reduce standby service.

DIESEL LOCOMOTIVES

5-21. Diesel locomotives require considerably less standby service than steam locomotives. In extremely cold climates, the problem of water supply is virtually eliminated. However, before using diesels in subzero temperatures, make the following modifications:

- Insulate all outside piping to protect against freezing.
- Preheat fuel because of the extreme difference between the unheated fuel and the flashpoint. Install heaters in engine compartments.

- Keep engine coolant warm to aid in starting the locomotive under extreme conditions. Under extreme conditions, locomotives must not be shut down unless engine block heaters are used.
- Keep storage batteries reasonably warm to secure maximum output. Place coils of pipe around the battery boxes through which the saline water flows.
- Small steam generators must be provided to heat the cab and passenger coaches. Install extra insulation in engine cabs.
- Windows of cabs and passenger coaches should have sealed, airtight, double-thickness glass to keep out the cold.

ROLLING STOCK

5-22. One of the greatest problems encountered with cars is the freezing of journal boxes. When cars stand for any length of time, the journal boxes freeze so tightly that the wheels slide instead of turning when an attempt is made to move them. Sometimes a train of 20 cars that has been stationary for even a few hours will have to be broken into three or four sections and each section started individually. After moving the cars a short distance, the heat generated by the axle action on the bearing will warm and thaw the journal box. This condition will naturally delay operations and can only be overcome by moving cars and trains as much as possible. Cars equipped with roller bearings are less of a problem. Extreme cold can cause steel car parts to become so brittle they break easily. As a result, knuckles may be broken when cars strike each other and drawbars pulled when frozen trains are started. When possible, cars should be switched as soon as they come into a yard and while the journal boxes are relatively warm. Trains on main tracks or in sidings should not be permitted to remain stationary longer than absolutely necessary.

FOREIGN SERVICE HOST-NATION EQUIPMENT

5-23. In many developing nations, U.S. forces may encounter exported new or used cars, locomotives, and equipment declared obsolete by American railroads. They will most likely encounter foreign built equipment, primarily British, German, Russian, or Chinese, that may differ significantly from what they are familiar with. The ERC and railway team commanders should thoroughly familiarize themselves with the capabilities, constraints, and requirements of providing rail services in this type of environment, and train accordingly.

TYPES OF EQUIPMENT

5-24. Diesel-electric locomotives should be thoroughly inspected to insure that they are as mechanically safe as possible to operate, and should be brought up to the best level of maintenance that existing facilities and supplies allow. It is not mandatory that diesel-electric locomotives be equipped to U.S. standards, but they must not present any operational hazards.

5-25. Electric locomotives require extreme care when working on or around them due to the threat of electrical shock. Soldiers should have specific training relative to electric train operations and safety around overhead catenary (power lines) before attempting any work around electric equipment.

5-26. Steam powered locomotives are still in use in some parts of the world, largely due to fuel availability and budget constraints. Steam locomotives have a proven ability to operate in extremely cold environments, which can be advantageous. However, the maintenance and support requirement disadvantages for steam operations far outweigh any advantages, unless there are adequate shop forces and repair parts readily available. Like electric train operations, Soldiers should have specific training in the operations and maintenance of steam locomotives before working around them. It is strongly recommended that any steam locomotive considered for use by U.S. forces is fully inspected according to the guidelines found in 49 CFR, Part 230, in order to prevent death or serious bodily injury to train crews.

5-27. Locomotives of all types, that appear to be serviceable, but with which HN operators have little proficiency, and U.S. Soldiers have no familiarity, and therefore little ability to adequately train, advise, and/or assist the HN, should be set-out on a siding and secured until they can be utilized by the HN.

5-28. Freight cars should be jointly inspected by the military and HN to determine load capacity and mechanical safety prior to use. Standards for the U.S. may be more comprehensive than required by the HN. U.S. standards are some of the safest and most stringent in the world and should be used only as a guide.

Prior use, standards, conditions, and requirements for HN use should be considered when utilizing for HN freight. U.S. Soldiers should insure that cars are not loaded over capacity or out of balance.

COMMON RULES

5-29. In the past, where the U.S. had exclusive use of trackage and equipment, absent of any interaction with HN personnel, operations and maintenance were conducted in accordance with U.S. doctrine and operating rules. Today, allied forces, HN support, and contractor support will share operating responsibilities. Representatives from all organizations involved in train operations must meet and determine what set of rules will be followed. All train crews should be made familiar with the operating rules before being placed into service. It should also be determined which language will be used for dispatching and train crew communication. All communications must be clearly transmitted and clearly understood by all personnel involved in train operations.

SUSTAINMENT OF RAIL OPERATIONS

5-30. Prior to commitment to conduct rail movements within the operational area, the ERC, and the railway planning and advisory team(s) must ensure there is an adequate HN maintenance and supply system in place to support train movements. Planners should consider track and structure repair and maintenance requirements, motive power, and rolling stock fueling and maintenance requirements. Further, planners should forecast an adequate supply of repair parts for all track, structure, signal systems, rolling-stock and motive power.

5-31. Also of significance is the availability of military or HN material handling equipment at both the originating and destination points of the rail movement. For example, it would be useless to move containers via rail if there were no container handling equipment available at the destination.

SUMMARY

5-32. After the ERC has conducted a detailed reconnaissance of a HN's railway trackage and facilities, it must examine what equipment a HN has to operate with, in order to develop a detailed operations plan for the combatant commander. When operating around the world, ERC personnel will encounter many different types of railway equipment, many of which they will be unfamiliar with. When this occurs, they must familiarize themselves with the equipment, and inspect the equipment for serviceability and safety. When working with HN personnel in an advise and assist role, common operating and safety rules must be agreed upon to create the safest working environment possible.

Chapter 6
Rail Security

One of the primary concerns of all commanders in the field is the security of the personnel and equipment assigned in their charge. This chapter provides security insights to consider in order to keep the railway safe from enemy actions, especially during an unconventional conflict.

RAILWAY SECURITY

6-1. Security measures of railway installations, equipment, and rail shipments at all levels of rail transport operations are HN responsibilities. The HN is ultimately responsible for security of its own railway assets and resources. ERC personnel in an advise and assist role with the HN can help to train the HN rail organizations on railway security. ERC and railway planning and advisory team commanders must take all active and passive security measures that are within their capabilities to protect their own Soldiers and equipment, and also aid the HN in its own security measures. However, ERC and railway planning and advisory team commanders do not have adequate organic personnel to provide necessary active security along rail lines or to guard bridges, tunnels, yards, and so forth. It cannot be assumed that maneuver forces will be available to provide this support. However, ERC and advisory team commanders may cooperate and coordinate with area commanders and local security agencies to the maximum extent possible to gain aid and support in their security endeavors.

COUNTERINSURGENCY OPERATIONS

6-2. Many enemies of the U.S. resort to fighting with unconventional methods such as terrorism and techniques of insurgency. As a result, counterinsurgency (COIN) operations must be undertaken. *Unconventional warfare* is activities conducted to enable a resistance movement or insurgency to coerce, disrupt, or overthrow a government or occupying power by operating through or with an underground, auxiliary, and guerrilla force in a denied area (JP 3-05). An *insurgency* is the organized use of subversion and violence to seize, nullify, or challenge political control of a region. Insurgency can also refer to the group itself (JP 3-24). *Counterinsurgency* is comprehensive civilian and military efforts designed to simultaneously defeat and contain insurgency and address its root causes (JP 3-24).

COIN Fundamentals and the ERC

6-3. The ERC's mission set directly supports several fundamental concepts behind COIN logistics. Because of the complex nature of a COIN operation, logisticians get involved and stay involved in the planning process from the earliest stages. COIN-specific logistics preparation of a new theater involves a detailed reconnaissance and analysis of HN logistics resources and capabilities, including rail capabilities. This is one of the primary missions of the ERC. Additionally, once in a new theater, a COIN operation involves empowering a local population and HN to secure and sustain themselves. Establishing or restoring a HN's essential services and supporting economic development are primary objectives. The ERC's advise and assist role directly supports these aims.

Unconventional Warfare and Insurgency

6-4. The lessons of logistics presenting a hard target to the enemy was learned during the Vietnam conflict, where tactics such as hardening logistics vehicles with steel plates and mounting crew served weapons wherever possible, were applied. These lessons were somewhat re-learned during Operation Enduring Freedom and Operation Iraqi Freedom. A similar mindset must be applied to rail operations in a COIN

environment. This section outlines some of the situations and conditions which may be encountered and some of the methods rail personnel may adopt to counter the tactics that irregular, insurgent forces might design to wreck trains or delay train movements. The type of defense that may be used varies with local conditions, degree of isolation, and proximity of other troops. Experience shows that aggressive attacks can cause considerable damage despite apparently foolproof security measures.

Sabotage and Harassment

6-5. Constant vigilance is necessary to prevent or reduce sabotage. Sabotage is an act or acts with intent to injure, interfere with, or obstruct the national defense of a country by willfully injuring or destroying, or attempting to injure or destroy, any national defense or war material, premises, or utilities, to include human and natural resources. Acts of sabotage may include placing sand in car journal boxes, water in fuel tanks, or bolts in a machine gearbox. These acts are done secretly making them more difficult to prevent. Inspect trains frequently for concealed saboteurs or guerrillas who may cut air hoses or train lines to force an emergency stop where guerrillas wait to attack. If tonnage can be handled with locomotive brakes only, operating trains without air brakes rules out this type of sabotage.

6-6. The enemy will harass the rail lines and installations, sometimes thru the use of sabotage tactics. Harassment is applying aggressive pressure or intimidation to an enemy force. They may utilize fire and explosives, to disrupt train traffic. The following will be likely enemy courses of action:

- Destroy bridges and tunnels.
- Destroy track (derailments and wrecks).
- Destroy buildings, shops, and terminal facilities.
- Destroy communication and power lines.
- Destroy locomotives and rolling stock.
- Capture and/or destroy equipment and supplies.
- Capture weapons and ammunition.
- Capture personnel and/or inflict personnel casualties.

Attacks on the Right-of-Way

6-7. Irregular forces, possessing a minimum of arms and explosives, may concentrate their efforts on train derailing and wrecking. In many instances, their primary goal may be stealing and pilfering supplies and ammunition after a wreck occurs. Delay may be secondary, but both goals may be accomplished simultaneously. To wreck trains, action must be directed against the track, switches, ballast, and bridges along the right-of-way.

Track

6-8. Tampering with the track and fastenings is the simplest way to cause a derailment. Removing enough spikes from rails will cause them to spread under the weight of a locomotive or buffer cars. Removing nuts and bolts from the joint bars is another method of causing rails to spread. Continuous welded rail lessens the danger of rails spreading, but it is doubtful that this type of rail will be found in many undeveloped areas. Ordinary track tools are enough to pull spikes and loosen joint bars. To make the work of the saboteur more difficult, joint bars have sometimes been welded into place and track spikes have been tack-welded to the rails. The consistent denial of track tools to the irregular forces is the first step to be taken. Tools are removed from the large toolboxes normally spaced along the right-of-way for worker convenience. Track tools should be safeguarded more zealously than their monetary or salvageable value warrants.

Roadbed

6-9. Unless the opposing forces have large stores of explosives or the tools and ability to make improvised explosive devices, extensive damage to ballast and subballast will probably not be attempted. Crews should be alert for mines and bombs when rounding sharp curves or at the bottom of steep grades where stopping in short distances may be difficult. The absence of a quantity of ballast or dirt is not an easy condition to detect

until the observers are quite close to the spot. Crews should be watchful for any piles of scattered ballast or dirt along the track in areas where they would not normally be found.

Track Barricades

6-10. Barricades thrown across the track may serve many purposes. Small, poorly armed bands may drop trees across the track to bring trains to a halt. Generally, when train guards are superior in number and arms, guerrillas will disperse and leave the crew to remove the blockade. In undeveloped countries, unconventional forces and terrorists block the track with anything available. They will often leave false evidence the barricade has been booby trapped. This makes removal much slower than usual. Guards must be constantly alert and careful because the terrorists leave the same evidence at barricades they did booby trap.

Bridges

6-11. Bridges and trestles are naturally vulnerable. Until repaired, their destruction can stop all movement. Irregular forces may not be interested in total destruction of such important rail facilities. Their primary mission may be to delay, pillage, and prevent certain types of cargo from reaching their destination. These same trains may be carrying freight important to their ultimate goal or cause. The average political or military group of a country with a limited rail network wants to achieve its goal without destroying transportation facilities.

6-12. Bridges and high embankments are excellent points for train wrecking and derailing. Bridges often span rivers and deep ravines. Therefore, efforts are often made to derail trains near these points in the hope that part of the train will topple to the ground or into the river below. It may prove profitable to keep guard forces in areas where simple derailments may have serious results.

6-13. Rail lines running through deep rock cuts offer good targets. The lack of operating space along the sheer cliffs makes cleaning up a wreck slow and extremely difficult.

6-14. There is a great possibility of a derailment where there are many bridges and high embankments. The engineman must be prepared to stop immediately upon derailment. One method that has been tried is mounting a white disk on each corner of the foremost buffer car. The engineer watches the disks constantly for any noticeable movement. Movement denotes a derailment and brakes are applied promptly. Another method is one that causes the brakes to be applied, independent of the engineman's actions, as soon as a derailment occurs. A method of doing this is to bring the brake pipe down to the wheels, 2 or 3 inches above the rails, with a glass tube installed in the line. When the wheels of the leading car leave the track, the glass tube drops down and breaks and the air brakes are applied.

Wayside Communications Facilities

6-15. Telephone and utility poles and lines are often targets for disrupting communications. Since these facilities are easily sabotaged, it may not be practical to keep these lines of communication open. If radio or digital communication is not available, trains can be dispatched with reasonable safety and expediency by using manual block operations. Where an attempt is made to keep lines open, enemy forces can often cut wire faster than breaks can be repaired. Cuts may also be made for the sole purpose of attacking repair crews for their tools and weapons when they arrive to repair breaks. Armed escorts should usually accompany repair personnel.

Wayside Signals

6-16. Wayside signals are in the same category as communications when it comes to tampering. Guerrillas can switch electrical leads and cause a signal to display a false aspect. The displayed aspect on main-track switch lights should not be depended on completely. It is a relatively simple matter to turn the lamp or to reverse the roundels and display false aspects. Switch points should always be observed to make sure they agree with the aspect displayed. It is doubtful whether electric signals should be relied on by the rail unit in guerrilla-infested territory.

Hand Signals

6-17. Railroad crews moving along a main track are always on the alert for hand signals displayed on the track ahead. Open stations will display "stop" or "proceed" signals depending on whether or not the station has any orders or instructions for the crew. When operating in adverse territory, hand signals observed between stations are regarded with suspicion. A red flare or fuse waved violently across the track is a universal stop signal. Opposing forces in possession of fuses and red lanterns can stop trains with little effort. The only countermeasure to use against unauthorized signals is to specify the exact manner in which a signal is to be given. A person unfamiliar with rail operations will usually hold a fuse at arm's length and wave it over their head in a half circle. A railroader usually swings it across their knees in a lower half-circle. Rail operators can designate signaling combinations as necessary. They should be classified, coded, and changed as necessary.

False Reporting

6-18. Because trains must be reported by each station they pass, precautions must be taken against guerrillas cutting in on a dispatcher's telephone circuit and reporting false information. Although the train dispatcher may know and can recognize all voices of their division, they must always call a station back and verify the report. Communication security procedures should be used at all times.

Precautions And Countermeasures

6-19. Whether irregular forces are well organized, well-armed, or not, countermeasures may be similar to those used in conventional warfare. In both conventional and unconventional warfare, distribution efficiency, eliminating all unnecessary distribution traffic, is the logistician's key defense. The use of rail in the first place, possibly to minimize roadway traffic, supports this concept. The most potent weapon of irregular forces is surprise. Rail personnel, especially train crews and those at outlying points, such as small stations, yards, enginehouses, and maintenance of way detachments, must stay alert at all times in case of an attack.

Enemy Detection

6-20. Detecting the enemy is the responsibility of every Soldier in the operational area. Detection is achieved by observation, reconnaissance, and surveillance. It is performed during all weather and light conditions and on any terrain throughout the rear area. Report any unusual or suspected activity. Use active and passive measures to stop the enemy. Detection efforts include the following: use of day and night observation devices, communications and intelligence, radar, remote sensor, and chemical and radiological detection equipment. These efforts provide early warning of enemy infiltration attempts or the use of chemical or nuclear weapons. They also aid in preventing reactions to false alarms (such as movements by friendly persons, defectors, or refugees).

Passenger Train Precautions

6-21. If passenger trains are kept in operation, it may be necessary to install steel plates over the windows and pile sandbags up to the bottom of the windows. Cover windows with steel-meshed wire to prevent grenades from being thrown into the cars. Doors are closed and secured to prevent guerrillas from boarding. When tracks are torn up or bridges blown, the train should back away if time and conditions permit. When enough motive power is available, a locomotive operated at the rear of the train is used to pull undamaged portions of the train back to safety if the locomotive or cars at the front end are derailed. Troop trains may carry a supply of ammunition and grenades for the crew and passengers to use in case of attack. Locomotives and train guard cars will be equipped with fire extinguishers and first aid kits. The security objective is to save personnel and equipment from capture, damage, or destruction.

Train Operations

6-22. Operations over a division experiencing frequent disruption of supply and passenger transport must change with the aims and tactics of the opposing forces. Trains should be operated at irregular intervals. In areas subject to guerrilla warfare, trains should not move on schedule or use traffic patterns that can be anticipated by the enemy, giving them an added advantage. Schedule and departure times should also be

encoded for transmission and the minimum number of personnel allowed access to this information. If logistical considerations permit, all movement should be made in daylight with several freight (supply) trains running close together, at random intervals, for mutual protection. At night, frequent roving patrols or armored trains should move over the lines at irregular intervals to prevent sabotage to tracks and structures. Also, if possible, and if parallel lines exist, vary the routes that trains will operate in the theater. There should not be any set pattern the enemy may use to their advantage. If irregular forces know when and where to expect trains, they can operate effectively against railroads with very little interruption. In a conventional war, the operation of passenger trains continues for military use but usually diminishes for civilian use if it can be done without disrupting the economy.

Right of Way Concealment

6-23. In areas where sniping is common or where heavy small arms fire is experienced or expected, brush and green growth along the right-of-way should be cut back as far as practicable (at least 20 feet on each side). Concealment is also important to small working groups. Where action is light and confined to sniping and trains are carrying guards or troops, it may be desirable to try to trap the guerrillas.

Pilot Trains

6-24. Conditions may require the operation of a pilot train to travel over a section of track a short time ahead of a following train. This train may be operated as a pilot train, as an escort to a troop or supply train, or as a security patrol train to prevent sabotage. A pilot train running interference for a troop or supply train moves ahead as short a distance as is feasible, safe, and consistent with operating conditions. The pilot train will move 2 to 5 minutes ahead of the second train. After the pilot train passes, the guerrillas do not have enough time to obstruct the track, remove a rail, spike a switch, and so forth, before the train they seek to derail has passed. A pilot train may consist of any combination of rolling stock. For night operations, the lead car can be rigged with a headlight powered from the locomotive generator. This car may be partially armored and carry a small machine gun or rifle crew for protection against small guerrilla groups or wayside snipers. Additional cars, similarly equipped and manned, may be pulled behind, carrying enough troops or guards for protection against attacks on the train if it is stopped. Depending on the firepower of the opposing forces, armor plates may be installed on the locomotive to protect the cab crew. Plating may also be necessary to cover key auxiliaries on the power plant area of diesels. These trains could be quite heavy. The locomotive may also have two cars attached to the front. These cars should be heavily loaded with anything that provides enough weight to explode a buried mine or to test the stability of the track by derailing before the locomotive reaches the spot. If the pilot train can safely pass over a given track section, an ordinary train should also be able to safely pass. It would be useless to have individual (light) engines act as pilot trains. They might safely pass over a track that had been tampered with, but a train of more weight would be derailed. If time delayed or remote controlled mines are used, then patrols must be increased to deny the opposing forces the opportunity of employment.

Emergency Supplies and Equipment

6-25. Aside from necessary weapons and first aid equipment, locomotives should be equipped with a full set of track tools in addition to those normally carried for emergency repairs. Track fastenings, spikes, jacks, sledges, crowbars, and even a limited number of ties and rails may be needed. If space on a train is an issue, prepositioning track repair equipment along the rail line will also facilitate quick repair. However, this can only be done in a more secure environment. Leaving track tools and supplies unsecured where enemy presence is likely would be a great benefit to opposing forces. The senior HN rail operator in charge must evaluate these risks and mitigate them appropriately. Engine and train crews and security guards aboard trains should have flare pistols for firing signals to indicate unauthorized stopping or attack. Train crews, security guards, and patrols may be furnished portable telephones that can be hooked to wire lines along the track to report attacks, derailments, location of interruptions, and similar information. Where the equipment is available and weather conditions permit, railway personnel and guards may be equipped with radio-telephones for similar purposes and communication between enginemen and train crews at the rear. DO NOT place cars containing explosives or flammable materials next to locomotives or cars containing troops or guards. Fire directed toward personnel might explode or set fire to the hazardous material.

Armored Trains and Cars

6-26. The tempo may change from sniping, wrecking, and pilfering to organized attack with heavy firepower when enemy forces and irregulars increase and possess large stores of ammunitions and explosives. Heavier armor may have to be installed on the pilot trains. Crude, improvised gondolas with mounted guns may change to armored tank-like structures mounted on flatcars. These can often be made by using 1/2-inch plates. Firing slots may be provided and revolving searchlights fitted into the roofs.

6-27. Armored trains may consist of specially armored cars, flatcars, or gondolas with tanks secured to them. Tanks are particularly effective because their moveable turrets and large caliber guns give long-range protection in all directions. When equipped with flame-throwing devices, tanks are very effective in searing growth that may be used as hiding places along the right-of-way. Boilerplate steel boxes or turrets installed on flatcars provide armor for troops and gun crews inside. These turrets may rotate and be rigged with firing slots, gun ports, and swivel lights. Reinforce locomotive cabs with armor plate thick enough to withstand machine gun and rifle fire. Cover locomotive windows with steel shutters to protect enginemen, but permit visibility.

Self-Propelled Cars

6-28. Self-propelled armored railcars may be used for piloting and patrolling. They can be used in pairs so that one may assist the other in the event of attack or derailment. They can be relatively light, which comes with advantages and disadvantage. Advantages to lightweight means they can be easily re-railed by light cranes or rerailers. They can also be moved to the side of the right-of-way when seriously disabled. The short time required to clear a line of these lightweight cars, after a derailment, is lower than clearing locomotives which have been derailed. However, as previously stated, one approach is to heavily load pilot cars with enough weight to explode a buried mine or to test the stability of the track. The senior operator in charge will have to examine the enemy situation in order to mitigate risks and arrive at the appropriate course of action. When self-propelled cars are wrecked and left unguarded, the guns (or at least the breech locks) must be removed. In some areas where an undeclared war is being fought, local government militia or constabulary may be taught to operate self-propelled track equipment. However, they must first be given detailed instructions about the rules of the road. Like all other rail operating personnel, they must be given periodic examinations and refresher instructions.

Derail Detection Devices

6-29. Unconventional forces may rig the track with an explosive device and permit an armored or pilot train to pass unharmed in the hope of wrecking the more valuable train. One or two idler cars, which may or may not be armed and equipped as described above, should be pushed in front of the locomotive. The derailment of the leading car warns the engine crew and often permits counteraction. The leading truck can be equipped with a spring-plunger device that starts automatic brake application in case of derailment.

Counterguerrilla

6-30. With extensive unconventional operations, precautions and countermeasures against attacks on rail facilities may be only partially successful. Such operations may reach such proportions the only practical defense would be to expel them from the area.

6-31. Counter-guerrilla tactical operations may be necessary. Denial of food and supplies, occupation of areas harboring and assisting them, and even the resettlement of communities to fortified centers may be required. HN employees around shops and terminals who could sabotage equipment should be carefully screened.

Deception

6-32. Two forms of deception are used against the enemy. The first is deceiving the enemy about our intention. The second is preventing the enemy from obtaining intelligence. A number of methods may be used to deny the enemy intelligence.

Camouflage and Concealment

6-33. Make camouflage loads appear to be non-military. Break the pattern of loads through the use of netting.

Obscuration

6-34. Obscuration may be used to degrade the enemy's vision. However, it should not degrade the visibility of the train crew. Only use obscurants, such as smoke, when everything else has failed. When possible, conduct rail operations during periods of darkness or fog to further reduce enemy observation.

OPERATIONS IN A CHEMICAL, BIOLOGICAL, RADIOLOGICAL, OR NUCLEAR ENVIRONMENT

6-35. Railroad main line operations are complex. They involve the movement of freight, passenger, and mixed (freight and passenger) trains from one terminal or yard to another over a division or subdivision of track. Adding to the complexity is that rail operations are an easy target for the enemy to conduct a chemical, biological, radiological or nuclear (CBRN) attack. Contingency plans should be developed with the capability and flexibility to continue operations in a CBRN contaminated environment. Protective measures and procedures to mitigate the effects of CBRN hazards should be integrated into daily operations. CBRN attacks can cause mass casualties and material losses, as well as contaminate terrain within the unit's operational environment. Increased mission oriented protective posture levels will result in heat buildup; reduced mobility; and reduction of visual, touch, and hearing senses. Rail unit operational efficiency and productivity will be degraded.

6-36. The enemy will use CBRN hazards to cause casualties, lower performance, and restrict the use of the terrain. The enemy may conduct a CBRN attack in hopes the unit will have to cease operations to conduct decontamination. The enemy might also conduct an attack so the unit will have to find uncontaminated terrain for travel. If train operations cannot be rerouted, operate only the least essential locomotives and railcars through the contaminated area. Cover all items on flatcars, gondolas, and open-top hopper cars with protective tarps. Use containerization to the maximum extent possible. Encapsulating and covering equipment will reduce the amount of contamination or eliminate it altogether. Train personnel should be in mission oriented protective posture gear and be prepared to augment inter-train communications with the use of standard rail operational hand signals. Close all doors and windows to lessen contamination. If the area is contaminated with radiation, the shielding property of the locomotive can be improved if sandbags are placed on the deck. Take immediate action to determine the type of hazard and its persistency. If the hazard is a nonpersistent blood or nerve agent, the train crew continues its mission. The hazard should disappear quickly. If the hazard is persistent (nuclear fallout, suspected biological agent, or liquid chemical agent), the train crew maintains full protection, takes action to limit further exposure to the hazard, and continues the mission. If possible, once the train is out of the contaminated area, it should be decontaminated before onward movement to prevent the spread of contamination. If operational decontamination cannot be accomplished, train personnel will remove contamination from all equipment surfaces that must be touched often and mark each railcar with the appropriate NATO CBRN marker. Perform thorough decontamination as soon as practical. Keep a record of each locomotive and railcar to include the date of contamination, the type of agent, and the date and method of decontamination used.

6-37. Conduct CBRN operations the same as in other type units with the exception of operations that will be degraded from a personnel standpoint rather than from an equipment standpoint. Toxic chemicals have little effect on motive power and rolling stock. However, nuclear detonation, depending on its proximity, might detail motive and rolling stock and damage equipment components (such as brake hoses and communication equipment).

6-38. When selecting rail facility sights, consider the protection afforded by each building against CBRN attack. Certain types of buildings offer excellent shelter from nuclear hazards and require a minimum of time and effort to adapt for use. The stronger the structure, the better the protection against blast effects. An overpressure system, such as the simplified collective protection equipment, can be used to convert existing structures to provide rest and relief for personnel from CBRN hazards.

SUMMARY

6-39. Security is a primary concern of any commander. Security, as it relates to rail operations, takes on even more importance in a COIN environment, even though certain precautions and countermeasures can be used in both conventional warfare and against an insurgency. Operating in an environment threatened by CBRN attacks brings a new set of considerations, precautions, and mitigation techniques.

Chapter 7
Rail Safety

One of the primary concerns of all commanders in the field is the safety of the personnel and equipment assigned in their charge. This chapter provides railway operating and safety guidelines that all American personnel must follow, and ERC personnel must motivate their HN counterparts to follow.

OPERATING AND SAFETY RULES

7-1. Within Army rail safety, there are rules that are operational in nature. These operating rules provide specific and sometimes procedural guidance on the safe way to physically operate a railway. Other rules are general safety rules that offer guidelines on personal conduct while performing one's duties. The ERC commander must ensure all personnel have a copy of these rules and are familiar with them. Periodic examinations are given to ensure that personnel completely understand the rules. U.S. personnel must always obey operating and safety rules, even when HN rail personnel are not obligated to do so.

Operating Rules and Regulations

7-2. There are many hazards that exist during railway train operations. These hazards include human errors, recklessness, mechanical failures, collisions, and wrecks. The design of operating rules to prevent these hazards has been formulated gradually. There are presently rules to cover all situations, which conceivably present a potential hazard. AR 56-3 states the U.S. Army will comply with the most current edition of the General Code of Operating Rules.

7-3. ERC personnel deployed to a theater of operation will not operate a railway. They will advise and assist the HN to operate the railway. While performing this advise and assist mission, ERC personnel will most likely not have the authority to impart U.S. standards and operating rules upon the HN rail personnel. However, every effort must be made to educate and persuade the HN workforce to operate as safely as possible throughout the course of operations.

7-4. While at home station, ERC personnel and contractors will most likely have a hand in the operation of railways. In these situations, they must adhere and ensure adherence to U.S. standards, rules, and guidelines.

Safety Rules

7-5. Railway shops, yards, and trains have always been places of potential personal injury and property damage. Safety rules simply require applying common sense precautions when performing duties in hazardous surroundings.

Safety Conditions

7-6. The following are a few of the changes which eliminated many conditions that once caused injury and death on the railroad:

- Automatic couplers.
- Electric signals.
- Rolling-stock improvements (steps, grab irons, running boards, and so forth).
- Use of diesel motive power instead of steam.

7-7. On many foreign railroads, safety conditions and safety devices vary considerably from the standards of U.S. railroads. In many foreign countries there is not enough clearance on bridges, buildings, tunnels, and

overhead lines and obstructions for personnel riding the tops and sides of cars. There is also a lack of uniformity in the safety devices (such as the number and location of grab irons, ladders, sill steps, braking devices, and couplers). These conditions require a constant watch by rail personnel unaccustomed to them.

WARNING SIGNS

7-8. The design of warning signs and labels is to prevent accidents. Personnel will label damaged or defective rail cars, engines, machines, switches, valves, or other apparatus with a danger sign, tag, or banner, and only remove it when it is safe to do so. Never operate rail cars, engines, machines, switches, valves, or other apparatus with attached danger signs, tags, or banners.

7-9. Use car labels and placards to ensure proper handling of certain types of shipments. These also inform yard personnel, inspectors, and switching and train crews of a car's contents. Affix labels or placards in conspicuous or prescribed places to either both sides of a car or the end of a car. In overseas theaters, labels and placards are usually multilingual and are used as prescribed by theater standard operating procedures.

URGENT-EXPEDITE LABELS

7-10. Use these labels for priority shipments only. These labels inform rail personnel of the shipment's importance so that it is expedited through yards and junctions.

GENERAL CAR LABELS

7-11. These labels usually have a colored stripe through the middle. General car labels inform railway personnel at a glance what type of commodity or supplies the car contains. The labels also help local personnel who cannot read English to quickly identify shipments by color association. These labels also give general information such as contents, weight, consignor, consignee, seal numbers (if used), and so forth. The consignor places car labels on both sides of the car.

RE-ICING PLACARDS

7-12. Use these placards only on refrigerator cars carrying perishable items. Place these placards at eye-level on both sides of the car and near the ice bunkers. These placards show when ice and salt (date and time) were placed in the bunkers at origin and include instructions on any re-icing en route.

SPECIAL PLACARDS

7-13. Special placards (figure 7-1) indicate requirements for special handling, easy coupling, and so forth. These placards identify the following:

- Explosives.
- Flammable articles.
- Fragile or perishable cargo.
- Missile components.
- Radioactive materials.
- Any other potentially hazardous items.

7-14. Such placards include DO NOT HUMP instructions if applicable. These special placards are usually printed in various color schemes to emphasize their meaning and importance. The consignor or loading activity affixes these placards to each side (or end) of a car before the car is released to the railway service for movement.

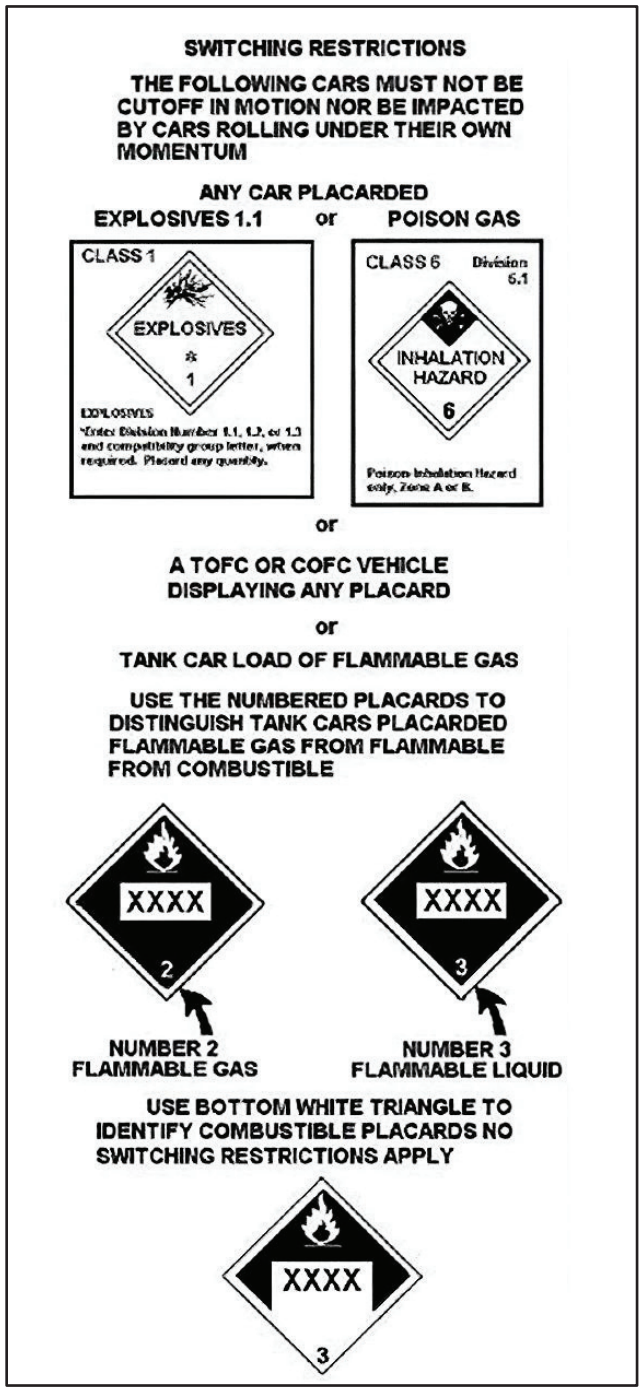


Figure 7-1. Special placards

STANDARD NATO CBRN MARKERS

7-15. Place standard NATO CBRN markers (figure 7-2 on page 7-4) on both sides of railroad rolling stock to indicate contamination. Railroad personnel will take appropriate actions to separate rolling stock for decontamination.

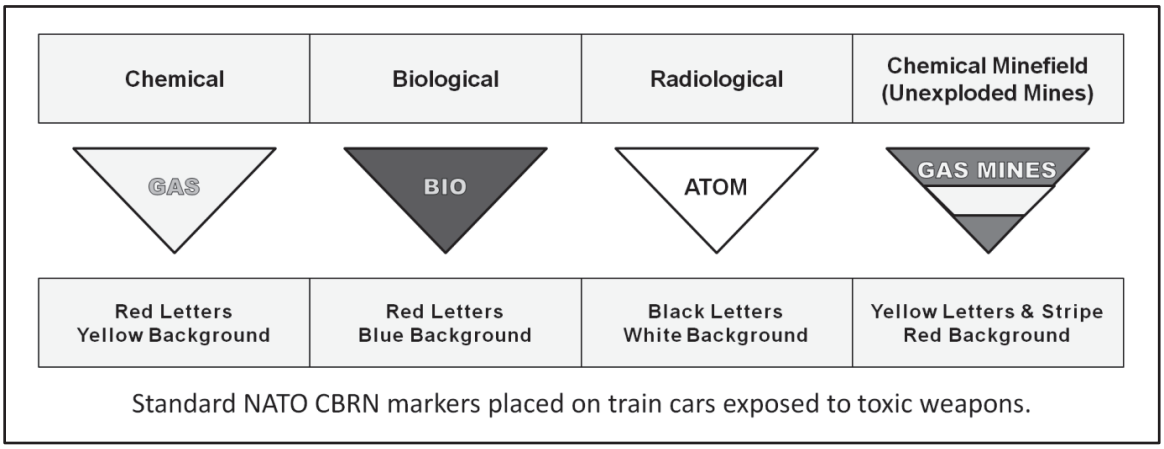


Figure 7-2. North Atlantic Treaty Organization chemical, biological, and radiological markers

ACCIDENTS

7-16. Rail accidents and/or incidents (may also be known as train accidents) involve any collision, derailment, or injury as a result of the operation of any rail equipment. Rail accidents will be reported as Class A through Class E accidents and identified as engineering, mechanical, transportation, or other, as appropriate on DA Form 285 (*Technical Report of U.S. Army Ground Accident*) (block 63) in addition to any local serious incident report format.

7-17. Rail accidents and/or incidents include—

- Accidents or incidents occurring while loading, off-loading, or receiving services.
- Damage to Army property handled as a loaded commodity.
- Damage and all injuries to Army personnel occurring while operating or riding rail equipment.

7-18. Rail accidents do not include accidents that are reportable under other major categories; for example, aircraft, missile, or chemical material accidents.

7-19. The following information covers trains and rail equipment under the jurisdiction of the Department of the Army:

- Equipment operated and exclusively controlled or directed by the Army. This includes rail equipment furnished by a contractor or another government agency when operated by Army train personnel.
- Equipment lent or leased to non-Army organizations for modification, maintenance, repair, test, contractor training, research, or development projects for the Army.
- Equipment under test by Army agencies responsible for research, development, and test of equipment.
- Equipment lent or leased by the Army to a non-Army organization for maintenance, repair, test, contract training, or experimental projects will not be charged to the Army if the non-Army organization that has operational control of the equipment has assumed the risk of loss. (This information does not negate the engineer or crew responsibility to report any applicable rail accident, injury, or death involving commercial or government owned property to the proper authorities.)

7-20. Many accidents are caused by people from outside agencies who have not had the safety training given to U.S. rail personnel and/or who ignore posted warnings and all rules of common sense. This is why ERC personnel must take their role of training HN rail operators on safety so seriously. In the U.S., extensive safety programs, safety rules, and supervisory discipline have helped. Similar focus must be adopted in a HN where safety may not be seen as a priority. However, in any environment, the human factor still remains and injuries and deaths do occur. Some common examples of accidents are those resulting from the following:

- Other agencies mishandling dangerous articles into and out of cars on railroad premises.
- Improper loading of dangerous material.
- Vehicles loaded with explosives.
- Flammables crashing into locomotives and trains at crossings.

NOTIFICATION REQUIREMENTS

7-21. All accidents and incidents will be reported in accordance with Army policy and unit requirements (see AR 385-10, *The Army Safety Program*, for reporting requirements). Any and all Army rail accidents and incidents are to be reported to the Transportation Branch Rail Safety Office within 24 hours of occurrence, per Transportation Branch Rail Safety Office Accident/Incident Reporting Policy found in AR 56-3. Information obtained from these reports are used to identify problem trend areas in order to develop accident prevention measures for the entire fleet (AR 385-10, *The Army Safety Program* and DA Pam 385-40, *Army Accidents Investigations and Reporting*). Harassment or intimidation of any person that is calculated to discourage or prevent such person from receiving proper medical treatment or from reporting an accident, incident, injury, or illness will not be permitted or tolerated.

RECORD KEEPING

7-22. The person in charge of any rail equipment involved in an accident and/or incident will retain all records relevant to the equipment in accordance with 49 CFR, Part II. Records include, but are not limited to, event recorder download, DD Form 862 (*Daily Inspection Worksheet for Diesel-Electric Locomotive and Locomotive Cranes*), records of air tests, any hazardous material records, radio logs, crew and passenger lists and statements, alcohol and drug tests, drawings or photographs made at the scene of the accident, articles of shipment, and other material which might be of assistance in investigating and determining the cause of the accident. The person(s) responsible for these records' custody shall make these records available upon request to the authorized safety investigator(s).

7-23. The information on the train's data recorder will be saved before any rail equipment involved in an accident or incident is put back into service.

RAIL ACCIDENT INVESTIGATION

7-24. In addition to the normal procedures required for investigating Army accidents, rail accidents require a copy of all data recorder information to be forwarded to the Defense Non-Tactical Generator and Rail Equipment Center, within 48hrs of the accident.

7-25. All rail accidents and/or incidents may be investigated by the Transportation Branch Rail Safety Office to determine if possible safety violations were the cause of the accident.

RAIL ACCIDENTS IN THEATER

7-26. Rail accidents in a theater of operation, where HN rail personnel and assets are being utilized and merely advised and assisted by ERC personnel, need not be reported to the Transportation Branch Rail Safety Office, unless a U.S. Service member was directly involved or sustained injury as a result of the incident. Otherwise, the combatant commander is the ultimate authority who will use discretion when deciding if an investigation is required.

SUMMARY

7-27. Human error is the biggest hazard of railway operations. To mitigate this hazard, a set of operating and safety rules has been established for the safety of all CONUS railroaders. CONUS Army personnel and contractors must follow these rules. The ERC will not have any authority to force these rules onto a HN. It is therefore the challenge of ERC to do all in their power to ensure that rail operations are done in the safest manner possible.

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Appendix A
Records and Reports

As advisors and assessors, ERC personnel must be familiar with multiple methods of reporting and recording rail operations in order to craft these methods to the needs of the supported HQs or HN railway personnel. This appendix discusses records and reports used in the rail industry as well as historical Department of the Army forms to assist RATs and RACs in conducting their advisory duties.

Required Reporting

A-1. ERC personnel will always be required to report certain information to higher HQs for basic situational awareness and planning purposes. This information could include—

- Total tonnages moved.
- Number of empty and loaded cars on hand.
- Number of serviceable locomotives.
- Delays and interruptions to traffic for the preceding 24 hours.
- Fuel requirements.
- Operational reports required by higher HQ and transportation movement control agencies for daily planning.

A-2. The following are historic forms that U.S. Army rail units used in the past. Some of these forms have been rescinded without replacement, and are therefore not current and are not used by the U.S. Army today. However, these forms, or a variation of these forms, may be helpful for ERC personnel while training HN rail organizations on administrative requirements. The forms and reports are as follows:

- DA Form 4090-R, *Combined Register of Trains and Comparison of Watches.*
- *Clearance Form "A"* (formerly DA Form 4091-R*).*
- DA Form 4092-R, *Train Order.*
- DA Form 4093-R, *Station Record of Train Movements and Operator's Transfer.*
- DA Form 5614-R, *Superintendent's Telegraphic Report of Accident.*
- DA Form 5615-R, *Set Out Report.*
- DA Form 5616-R, *Car Inspector's Train Report.*
- DA Form 5617-R, *Daily Statement of Cars On Hand.*
- DA Form 5618-R, *Conductor's Wheel Report.*
- DA Form 5619-R, *Daily Empty Car Situation Report.*
- DA Form 5620-R, *Daily Installation Situation Report.*
- DA Form 5706-R, *Track Bulletin.*

Combined Register of Trains And Comparisons of Watches (DA Form 4090-R)

A-3. Train registers were located at stations designated by timetable. This register was a permanent record of the movement of trains over the division. The conductor (or the engineman if there is no conductor) checked and signed the register before departing from a register station. It was the responsibility of the train crew to enter the required information on the register and then report the train to the train dispatcher. The use of this form was to maintain a record of time comparisons.

CLEARANCE FORM "A"

A-4. Clearance Form "A" was previously known as DA Form 4091-R. The form is now obsolete and format provided for advisory and instructional purposes. A train first received a Clearance Form "A" before leaving a train order station. This document was not required if a train was to do station work or enter a siding. Information entered on the document had to be accurate and correct without any erasures or alterations. The number of orders for the train and the number of each order had to be entered on the document and checked with the train dispatcher. The number had to be identical with those entered in the dispatcher's train-order book. The dispatcher would give the station agent the approval, the time the clearance form was checked for accuracy, and initialed for the chief train dispatcher. They made a record of the clearance in their book. The station agent entered the information received on the clearance form. The clearance form and train orders were then given to the proper personnel to be carried out.

A-5. Before leaving, the conductor and engineman had to know the numbers shown on the clearance form corresponded with the orders received and that all information required on the document was correct. A space headed DO NOT LEAVE BEFORE was provided on the form. This space was used for many purposes, but the most important one was the spacing of trains. By designating the time the train should leave, the train dispatcher controlled the distance and time between trains. See figure A-1 for an example Clearance Form "A".

CLEARANCE FORM "A"	DATE
STATION	
CONDUCTOR AND ENGINEER	
ORDERS (If no orders, indorse "NONE")	
OK AT (Time)	CHIEF DISPATCHER
DO NOT LEAVE BEFORE	
BLOCK (Fill in only when operating under Manual Block System)	OPERATOR
Conductor and engineer must have a copy and see that their train is correctly designated in the above form, also that the numbers of all train orders received correspond with numbers inserted above.	
OPERATOR MUST RETAIN A COPY	

Figure A-1. Example Clearance Form "A"

TRAIN ORDERS (DA FORM 4092-R)

A-6. DA Form 4092-R authorized the movement of trains not provided for in timetables. A train dispatcher issued the train order orally by radio or by telephone through a station agent. The station agent wrote the order as received and repeated back the information to the sender to make sure it was accurate. The written order was handed to passing train crews. Train orders were numbered consecutively each day beginning at 0001 hours and were in effect until they had been fulfilled, superseded, or annulled. When subdivisions of a railroad were under the jurisdiction of more than one dispatching office, a different series of numbers were used by each office to prevent duplicating numbers for crews operating in more than one train dispatchers'

territory. Orders were addressed to station agents, conductors, enginemen, or anyone who was acting as a pilot.

A-7. A train order conveyed the dispatcher's instructions to the crew. An order could amend, annul, or supersede the class and directional superiority that the timetable establishes. However, it did not waive compliance with a rule for one train unless it instructed another crew to protect the first train.

A-8. When the train order controlled movements, the dispatcher's movement plan had to be totally correct. Orders had to be transmitted, relayed, or otherwise delivered in a foolproof manner. The language of the order had to be unmistakably clear to prevent misinterpretation. Strict accuracy of stated time, engine number, station call letters, and direction was critical.

A-9. Crews receiving train orders had to properly interpret and execute the orders. With involved orders or a series of orders, careful reading and concentration was necessary. Crew members had to read and repeat orders and then listen to others read and repeat them. It was prohibited for one member to read and interpret orders to other members. Other members could be influenced by incorrect interpretation and they, in turn, may also misinterpret the order. Discussing complicated orders was advisable, and complete and unanimous agreement should exist before acting on an order.

A-10. Train dispatchers wrote train orders in clear and legible handwriting. In writing orders, even hours would not be used in stating time. Specifying time in even hours is conducive to misunderstanding. When time normally would be 1300, it should be adjusted a little ahead or a little behind (for example 1301 or 1259).

A-11. When dictating train orders, the dispatcher wrote in the train-order book as they read. They recorded all stations and trains to which the order was addressed. Each operator copied the entire text of the order in longhand and put their call letters in the heading. Operators repeated the order from their copy in the same sequence as they were addressed. Figures, engine numbers, and dates were given by pronouncing the number followed by the identification of the individual digits that made up the number. For example, Eng. 345 (three hundred forty-five, three-four-five) or 14 November (fourteen, one-four).

A-12. After the order was copied, the first operator addressed by the train dispatcher read the order back. As the operator repeated the order, the dispatcher underscored each word. If the repetition was correct in all respects, the dispatcher completed the order by saying "complete" and giving the exact time. The word "complete" (abbreviated "com"), was written along with the time in the appropriate spaces at the bottom of the train order. Then, in turn, each of the other operators repeated the order from their written copy.

A-13. As the order was read, the dispatcher underscored each word in their train-order book and completed the order as they did for the first operator. Train orders had no validity until they had been completed according to the superiority of the particular trains. The order for the superior train, which was being restricted, had to be completed before the order for the inferior train, which the order helped. The only exception to this procedure was known as the "X" response.

A-14. When an order had been transmitted to several offices, the receiving operators repeated the order at once. The order was repeated in the succession in which the offices were addressed. The train dispatcher and all operators on the wire listened for any flaws or omissions in the repetitions. Occasionally, the last operator would repeat the order first. This was permitted when the order could be completed and delivered to an inferior train, which would otherwise have been delayed while several other operators were repeating the order to the dispatcher. When this occurred, the dispatcher directed that the operator receiving the order for the superior train gave the "X" response. This allowed the operator copying the order for the inferior train to repeat their order first and, when finished, to have it delivered. Once the "X" response was given, the order would be repeated and made complete to the inferior train before the operator copying for the superior train repeated their order. When the "X" response had been given, the order to the superior train became a holding order and could not be delivered until it had been repeated and completed.

Station Record Of Train Movements And Operator's Transfer (DA Form 4093-R)

A-15. Station operators used this form to record all train movements within their jurisdiction. Each station operator recorded the time of their shift and specific information on train orders and signals.

DISPATCHER'S RECORD OF TRAIN MOVEMENTS (DA FORM 5613)

A-16. As a train entered or left a terminal yard or station, the agent or operator notified the train dispatcher by telephone. The train sheet was kept in the dispatcher's office and provided a continuous, running record of all trains moving on the division. Therefore, the dispatcher could anticipate train meets and issue appropriate train orders.

SUPERINTENDENT'S TELEGRAPHIC REPORT OF ACCIDENT (DA FORM 5614-R)

A-17. When a personal injury occurred or when the main line was blocked and train movements were affected, a report was submitted by the fastest available means to the chief train dispatcher. The conductor, track foreman, or yardmaster submitted a report for any accident involving cars, locomotives, or trains. The chief train dispatcher promptly forwarded the report to higher HQ.

A-18. The general superintendent of transportation prepared this form when they received a report of a train accident. This was an essential report to higher authority or other personnel concerned. Division chief train dispatchers through railway command channels had to submit accurate and concise information for its preparation. The accident number and the time and date of the accident were entered at the top of the form.

CAR INSPECTOR'S TRAIN REPORT (DA FORM 5616-R)

A-19. This report was prepared for each train that was inspected when it entered or left a yard or terminal.

DAILY STATEMENT OF CARS ON HAND (DA FORM 5617-R)

A-20. Station agents and yard clerks prepared this report using information obtained from the car- record book and/or from a physical check of the cars on hand in the yard or station sidings. This form showed the car number, date received, type of contents, consignee, and length of and reason for any delay. The report was forwarded daily through channels to the battalion commander (division superintendent) for their information and reports to higher authority.

CONDUCTOR'S WHEEL REPORT (DA FORM 5618-R)

A-21. The wheel report was a record of the train's run. It also contained most of the information shown on the train consist (a list of cars that make up a train). The conductor prepared the report and completed the proper blanks to show the following:

- Train and engine numbers.
- Times of departure and arrival.
- Cars handled, picked up, and set out.
- Names of yards and stations where stops were made or the mileage or kilometer point if the place was undesignated.
- Names of the crew members.
- Unit designation in military railroading.

A-22. Any special comments were recorded in the remarks column. At the end of the trip, the wheel report was completed and sent to the chief train dispatcher or to the superintendent of work involved in setting off and picking up car service. Additional reports made by the conductor may have included forms dealing with freight such as explosives, flammables, and perishables.

DAILY INSTALLATION SITUATION REPORT (DA FORM 5620-R)

A-23. All rail activities prepared this report at depots, railheads, yards, terminals, ports, or other points where loading, unloading, or movement of cars took place. They prepared this report at a fixed time each day. This report was completed and consolidated at each level of command. It reflected the situation as of the hour it was compiled and the progress of operations over the preceding 24 hours for the entire division. The report was based on data obtained by a thorough physical check of all yards, stations, depots, docks, warehouses,

loading and unloading tracks, or other tracks where cars were stored. The report was then filed as a permanent station record.

TRACK BULLETIN (DA FORM 5706-R)

A-24. Within track warrant control territory and other territories designated by special instructions; the train dispatcher, as required, would issue DA Form 5706-R. Bulletins contained information as to all conditions affecting the safe movement of trains or engines. When track bulletins were authorized, trains and engines had to receive a track warrant at their initial station unless the train dispatcher instructed otherwise. All track bulletins must be listed on the track warrant. The conductor and engineer had copies of all track bulletins listed. Each crew member had to read and understand the requirements of any track bulletin they received.

MAINTENANCE OF WAY REPORTS

A-25. In the past, the transportation railway engineering company prepared maintenance of way reports. These reports covered normal operations in repair and rehabilitation work and were used by the battalion commander and higher HQ. Special reports were promptly made by electrical means on the extent of damage to bridges, buildings, tracks, and tunnels resulting from enemy or guerrilla action, floods, sabotage, slides, wrecks, or other causes. All personnel casualties were reported. If tracks were obstructed, an estimate was made as to the time required to restore traffic. Progress reports are made periodically, as directed, until repairs were completed and the line was open for train movement.

EQUIPMENT MAINTENANCE REPORTS

A-26. Equipment maintenance reports, made by the transportation equipment maintenance companies, included the daily enginehouse reports. The equipment maintenance reports showed the following:

- Available motive power.
- Number of locomotives undergoing repairs
- Estimated time when each will be ready for service.

A-27. Reports also included information about any new motive power placed in service and the fuel situation. Car reports gave the number of cars repaired, the number of cars awaiting repairs, and the number of loaded cars. Reports of wrecked cars and locomotives would include the extent of the damage.

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Appendix B

Railway Planning Example

This appendix contains an example of railway planning. Use this plan for the operation of any rail system. U.S. Army rail personnel who are in an advise and assist role with HN personnel and organizations may use this planning example as an educational tool, or to enhance the HN planning procedures.

SITUATION

B-1. Plan for the operation of a rail system to move supplies in a theater of operations. The target date for the initiation of service is on 1 December. Route all rail tonnages originating in the port to the railhead over the main line of the system shown in figure B-1.

Note: All tonnages are expressed and computed in STONs. All computations resulting in a fraction are raised to the next higher whole number.

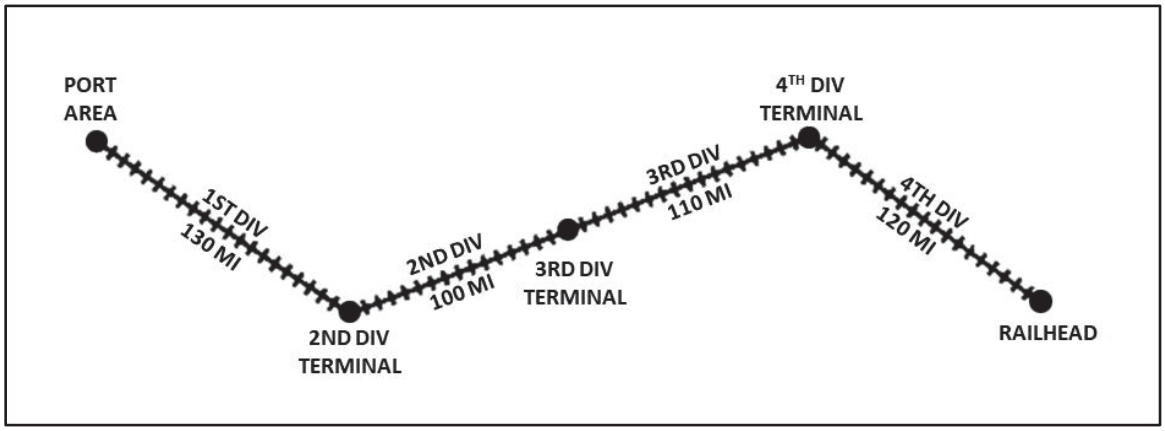


Figure B-1. Hypothetical rail system for planning

PLANNING DATA

B-2. Planning depends on the size and type of rails, condition of crossties, rail and ballast, washout and rockslide potential, number of single and double main lines, and the availability of sidings or passing tracks.

TRACK

B-3. If there is a usable double track, trains may operate in both directions without delays in schedules. However, rail organizations often take the usable parts of a damaged double track to make one single main line with good passing tracks. Computations in this appendix are based on a single track.

Number:	Single track (unless otherwise stated)
Gauge:	Standard (56.5 inches)
Condition:	All divisions: Good to fair
Percent of Grade:	All divisions: 1.5 percent or less

Ruling Curve: All divisions: 5 degrees

Weather: All divisions:
Summer: +60ºF to +95ºF
Winter: +35ºF to -20ºF
Wet weather: Local and temporary
Passing Tracks: First divisions - 15
Second division - 9
Third division - 11
Fourth division - 14

MOTIVE POWER

B-4. Motive power consists of all self-propelling equipment found on a railroad. The most common motive power refers to locomotives.

Road Engines

B-5. U.S. Army 0-6-6-0, 120 STONs, diesel-electric locomotive.

Switch Engines

B-6. U.S. Army 0-4-4-0, 60 STONs, diesel-electric locomotive.

ROLLING STOCK

B-7. Rolling stock refers to a collection of a large group of railway cars.
Boxcars: 40-STON rated capacity
Gondolas: 40-STON rated capacity
Flatcars: 50-STON rated capacity

FIRST COMPUTATION

B-8. Determine the TD for each of the four railway divisions.

$$TD = \frac{(NPT + 1)}{2} \times \frac{24 \times S}{LD}$$

S = 10 mph (refer to Figure B-2 on page B-6)

Where – TD = train density
S = average speed
LD = length of division

STEP 1:

First Division: $TD = \frac{(15 + 1)}{2} \times \frac{24 \times 10}{130} = \frac{16}{2} \times \frac{240}{130}$

$\frac{3,840}{260}$ = 14 + of 15 trains

STEP 2:

Second Division: $TD = \frac{(9 + 1)}{2} \times \frac{24 \times 10}{100} = \frac{10}{2} \times \frac{240}{100}$

$\frac{2,400}{200}$ = 12 trains

STEP 3:

Third Division: $TD = \frac{(11 + 1)}{2} \times \frac{24 \times 10}{110} = \frac{12}{2} \times \frac{240}{110}$

$\frac{2,880}{220}$ = 13 + 14 trains

STEP 4:

Forth Division: $TD = \frac{(14 + 1)}{2} \times \frac{24 \times 10}{120} = \frac{15}{2} \times \frac{240}{120}$

$\frac{3,600}{240}$ = 15 trains

SECOND COMPUTATION

B-9. Determine the EDT of this rail line during winter months using single-engine operation. You must use the following formulas:

EDT = NDT of most restrictive division
NDT = NTL X TD
NTL = GTL X .50
$GTL = \frac{DBP \times WF}{RR + GR + CR}$
DBP = CTE -- (Total weight of engine in STONs x 20 pounds per STON)
$CTE = \frac{STE}{2}$
$CTE = \frac{\text{Weight on drivers (lb)}}{25\% \text{ adhesion factor}}$

Where: EDT = end delivery tonnage
NDT = net division tonnage
NTL = net trainload
GTL = gross trailing load
DBP = drawbar pull
WF = weather factor
RR = rolling resistance
GR = grade resistance
CR = curve resistance
CTE = continuous tractive effort
STE = starting tractive effort

STEP 1: COMPUTE THE STE.

$STE = \frac{\text{Weight on drivers (lb)}}{4}$

$\frac{240,000}{4}$ = 60,000 pounds

STEP 2: COMPUTE THE CTE.

$CTE = \frac{STE}{2}$

$= \frac{60,000}{2}$ = 30,000 pounds

STEP 3: COMPUTE THE DBP OF THE ROAD ENGINE.

DBP = CTE - (Total weight of engine in STONs x 20 pounds per STON)

= 30,000 - (120 X 20)

= 30,000 - 2,400 = 27,600 pounds

STEP 4: COMPUTE THE GTL.

$$GTL = \frac{DBP \ X \ WF}{RR + GR + CR}$$

Where: DBP = 27,600 pounds (preceding calculations)
WF = 80 percent
RR = 6
GR = 1.5 percent X 20 = 30
CR = 5 degrees X 0.8 = 4

$$GTL = \frac{27{,}600 \text{ pounds x } .*80}{6 + 30 + 4}$$

$$\frac{22{,}080}{40} = 552 \text{ STONs}$$

STEP 5: COMPUTE THE NTL.

NTL = GTL x .50

= 552 x .50 = 276 STONs

STEP 6: COMPUTE THE EDT OF THE SYSTEM BY DETERMINING THE NDT OF THE MOST RESTRICTIVE DIVISION.

NTL x TD = NDT

First Division 276 x 15 = 4,140 STONs
Second Division 276 x 12 = 3,312 STONs
Third Division 276 x 14 = 3,864 STONs
Fourth Division 276 x 15 = 4,140 STONs
EDT = NDT of second division (most restrictive)
EDT = 3,312 STONs

THIRD COMPUTATION

B-10. Determine the rolling stock requirements for this rail system when operating at maximum capacity during winter months using single-engine operation. Each type of freight car will move the following percentages of the EDT:

Boxcars:50 percent of EDT
Gondolas:25 percent of EDT
Flatcars:25 percent of EDT

STEP 1: COMPUTE THE PORTION OF THE EDT TO BE MOVED IN EACH TYPE OF RAILCAR:

Boxcars: EDT x 50 percent = 3,312 x .50 = 1,656 STONs
Gondolas: EDT x 25 percent = 3,312 x .25 = 828 STONs
Flatcars: EDT x 25 percent = 3,312 x .25 = 828 STONs

STEP 2: COMPUTE ROLLING STOCK REQUIREMENTS FOR ONE DAY'S DISPATCH. YOU MUST APPLY THE FOLLOWING FORMULAS:

$$\text{Total cars required} = \frac{\text{EDT (by type car) x TAT x 1.1}}{\text{Average payload for type of car}}$$

$$1\text{ DD} = \frac{\text{EDT (by type car)}}{\text{Average payload for type car}}$$

Where: EDT = End Delivery Tonnage
TAT = turn-around time
DD = day's dispatch

Note: Average payload in STONs per type car = $\frac{\text{Rated capacity}}{2}$

Therefore, 1 day's dispatch for all types of cars is computed as follows:

Boxcars: $1\text{ DD} = \frac{1,656}{20} =$ 82 + or 83 cars

Gondolas: $1\text{ DD} = \frac{828}{20} =$ 41 + or 42 cars

Flatcars: $1\text{ DD} = \frac{828}{25} =$ 33 + or 34 cars

Total cars in 1 DD = 159 cars

B-11. Rolling stock requirements are based on a turnaround time of 11 days. Therefore, total rolling stock requirements are computed as follows: 1 DD x TAT = cars required x 1.1 (reserve factor) = total cars required (also see figure B-2 on page B-6). 1 DD X TAT = cars required X 1.1 (reserve factor) = total cars required.

Boxcars:	83 x 11 = 913 x 1.1 =	1,004+ or 1,005 cars
Gondolas:	42 x 11 = 462 x 1.1 =	508+ or 509 cars
Flatcars:	34 x 11 = 374 x 1.1 =	411+ or 412 cars
	Total rolling stock requirements: 1,926 cars	

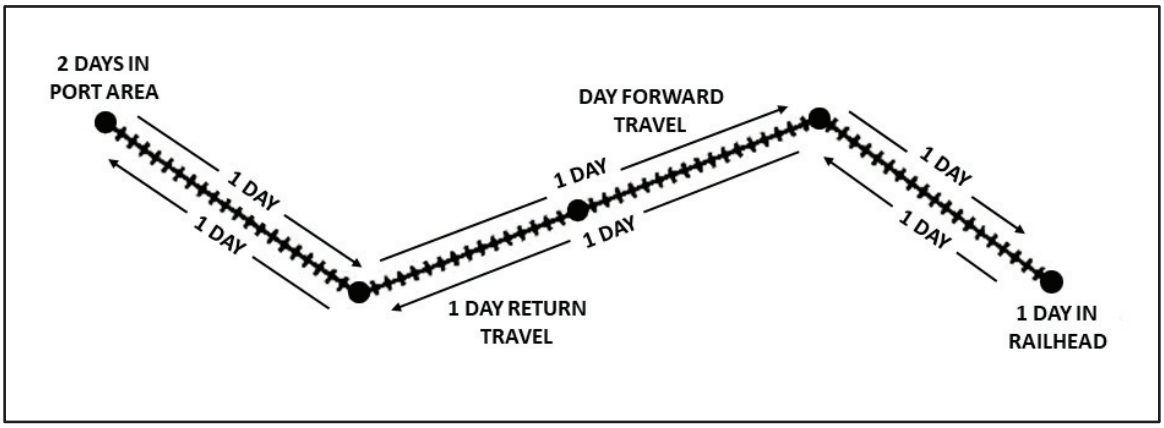


Figure B-2. Determination of turnaround time in days

FOURTH COMPUTATION

B-12. Determine the road and switch engine requirements for the operation of the system at maximum capacity during winter months using single engine operation.

STEP 1: COMPUTE FOR ROAD ENGINES REQUIRED.

B-13. Use the following equation to determine the number of road engines required.

$$\text{Number of road engines} = TD \times \frac{(RT + TT)}{24} \times 2 \times 1.2$$

Where: TD = train density
RT = running time
TT = terminal time

COMPUTE FOR FACTORS

B-14. Compute the running time for each division.

	RT / TD	(Length of division ÷ average speed)
First division:	15	130 ÷ 10 = 13
Second division:	12	100 ÷ 10 = 10
Third division:	14	110 ÷ 10 = 11
Forth division:	15	120 ÷ 10 = 12

Note: Average value for terminal time of diesel-electric motive power is 3. Average value for steam is 8.

COMPUTE REQUIREMENTS

B-15. The following computations shows the number of road engines (per division) required for operation over a given railway division.

$$\text{First division: } 15 \times \frac{(13 + 3)}{24} \times 2 \times 1.2 = 36 \times \frac{16}{24} = \frac{576}{24}$$

Second division: $12 \times \frac{(10 + 3)}{24} \times 2 \times 1.2 = 28.8 \times \frac{13}{24} = \frac{274.4}{24}$

Third division: $15 \times \frac{(13 + 3)}{24} \times 2 \times 1.2 = 36 \times \frac{14}{24} = \frac{504}{24}$

Forth division: $15 \times \frac{(12 + 3)}{24} \times 2 \times 1.2 = 36 \times \frac{15}{24} = \frac{540}{24}$

Total road engines required = 24 + 16 + 21 + 23 = 84 road engines

STEP 2: COMPUTE FOR SWITCH ENGINES (TABLE B-1).

B-16. Use table B-1, as an example, to determine the number of switch engines required.

Table B-1. Switch engine computations

		Cars Dispatched and Received per Day	*Cars Passing per Day*		*Computation Factor*		*Switch Engines Required*
Port							
	Terminal	159 x 2		÷	67	=	4 + or 5
2nd Division							
	Terminal		159 x 2	÷	100	=	3 + or 4
3rd Division							
	Terminal		159 x 2	÷	100	=	3 + or 4
4th Division							
	Terminal		159 x 2	÷	100	=	3 + or 4
Railhead		159 x 2		÷	67	=	4 + or 5
					Subtotal	=	22
					+ 20 percent reserve (4+ or 5)	=	5
					Total	=	27

FIFTH COMPUTATION

B-17. Determine the number of switch and road crews required to support this rail system.

STEP 1: COMPUTE FOR ROAD CREWS REQUIRED.

Road crews = $TD \times 2 \times \frac{(RT + 3)}{12} \times 1.25$

COMPUTE FOR FACTORS

B-18. Compute the running time for each division.

	TD	RT (Length of div ÷ avg speed)
1st division:	15	130 ÷ 10 = 13
2nd division:	12	100 ÷ 10 = 10
3rd division:	14	110 ÷ 10 = 11
4th division:	15	120 ÷ 10 = 12

COMPUTE FOR ROAD CREW REQUIREMENTS

B-19. The following computations shows the number of road crews (per division) required for operation over a given railway division.

First division: Road crews = $15 \times 2 \times \frac{(13 + 3)}{12} \times 1.25 = 37.5 \times \frac{16}{12} = \frac{600}{12} = 50$ crews

Second division: Road crews = $12 \times 2 \times \frac{(10 + 3)}{12} \times 1.25 = 30 \times \frac{13}{12} = \frac{390}{12} = 32 +$ or 33 crews

Third division: Road crews = $14 \times 2 \times \frac{(13 + 3)}{12} \times 1.25 = 35 \times \frac{14}{12} = \frac{490}{12} = 40 +$ or 41 crews

Forth division: Road crews = $15 \times 2 \times \frac{(12 + 3)}{12} \times 1.25 = 37.5 \times \frac{15}{12} = \frac{562.5}{12} = 46 +$ or 47 crews

Total road crews required = 50 + 33 + 41 + 47 = 171 road crews

STEP 2: COMPUTE FOR YARD SWITCHING CREWS REQUIRED (DO NOT INCLUDE RESERVE SWITCH ENGINES).

Switching crews = SE x 2 x 1.25

Port area:	Switching crews = 5 x 2 x 1.25 = 12 + or 13
Second division terminal:	Switching crews = 4 x 2 x 1.25 = 10
Third division terminal:	Switching crews = 4 x 2 x 1.25 = 10
Fourth division terminal:	Switching crews = 4 x 2 x 1.25 = 10
Railhead:	Switching crews = 5 x 2 x 1.25 = 12 + or 13
	Total switching crews required = 56

STEP 3: DETERMINE TOTAL NUMBER OF SWITCHING AND ROAD CREWS REQUIRED.

Road crews = 171
Switching crews = 56
Total switch and road crews = 227

SIXTH COMPUTATION

B-20. Determine the monthly engine fuel, lubricants, and repair parts requirements for the operation of this system.

STEP 1: COMPUTE FUEL REQUIREMENTS FOR ROAD ENGINES (TABLE B-2).

Table B-2. Road engine fuel requirements

	TD	*x*	*Two-Way Travel*	*x*	*LD*	=	*Train Miles per Day*
1st Division	15	x	2	x	130	=	3,900
2nd Division	12	x	2	x	100	=	2,400
3rd Division	14	x	2	x	110	=	3,080
4th Division	15	x	2	x	120	=	3,600
Total train miles per day						=	12,980
Legend: TD = train density LD = length of division in miles							

12,980 train miles per day x 2.5 gal per train mile = 32,450 gallons per day
32,450 gallons per day x 30 days = 973,500 gallons per month

973,500	Gallons per Month
+ 48,675	5-Percent Reserve
1,022,175	Total Gallons per Month

STEP 2: COMPUTE FUEL REQUIREMENTS FOR SWITCH ENGINES (DO NOT INCLUDE RESERVE SWITCH ENGINES) (TABLE B-3).

Table B-3. Switch engine fuel requirements

Number of Switch Engines	*x*	*Hours per Day Operations*	*x*	*Rate of Fuel Consumption (Gallons per Hour Locomotive)*	=	*Daily Require-ment (gallons)*
22	x	20	x	8	=	3,520

3,520 gallons per day x 30 days = 105,600 gallons per month

105,600	Gallons per Month
+ 5,280	5-Percent Reserve
110,880	Total Gallons per Month

STEP 3: COMPUTE TOTAL FUEL REQUIREMENTS.

1,022,175	Road Engine Requirements per Month in Gallons
+ 110,880	Switch Engine Requirements per Month in Gallons
1,133,055	Total Requirements per Month in Gallons

STEP 4: COMPUTE MONTHLY LUBRICANT REQUIREMENTS IN STONS (TABLE B-4).

Table B-4. Monthly lubricant requirements computations

	TD	*x*	*Two-Way Travel*	*x*	*Lubricants (STONs per Month per Train per Day)*	=	*Lubricants (STONs per Month)*
1st Division	15	x	2	x	.5	=	15
2nd Division	12	x	2	x	.5	=	12
3rd Division	14	x	2	x	.5	=	14
4th Division	15	x	2	x	.5	=	15
			Total Lubricants per Month			=	56 STONs
Legend: TD = train density STON = short ton							

STEP 5: COMPUTE MONTHLY REPAIR PARTS REQUIREMENTS IN STONS (TABLE B-5).

Table B-5. Monthly repair parts requirements computations

	TD	*x*	*Two-Way Travel*	*x*	*Repair Parts (STONs per Month per Train per Day)*	=	*Repair Parts (STONs per Month)*
1st Division	15	x	2	x	1.5	=	45
2nd Division	12	x	2	x	1.5	=	36
3rd Division	14	x	2	x	1.5	=	42
4th Division	15	x	2	x	1.5	=	45
			Total Spare Parts per Month			=	168 STONs
Legend: TD = train density STON = short ton							

Appendix C

Conducting Rail Load Operations

As part of the deployment process, both CONUS and OCONUS, units must prepare to utilize rail. Often, rail movement is the most reasonable and expeditious mode to move the large volumes and weights of equipment necessary for units to conduct their assigned mission.

PLAN

C-1. Rail movement begins with the development of the unit deployment list. Commanders, staffs, and planners should identify what equipment the organization will need to conduct operations and successfully accomplish the mission. This process is driven by operational need and grounded in logistic reality.

UNIT MOVEMENT OFFICER

C-2. The unit movement officer (UMO) is the commander's appointed representative and attends to the details of getting the unit ready for movement. Commanders appoint, in writing, an officer or NCO (E-6 or above) as a UMO and an alternate (E-5 or above). The UMO, in conjunction with the unit Movement Warrant Officer, is responsible for preparing the rail load plan in the Transportation Coordinator's – Automated Information for Movements Systems II (commonly known as TC-AIMS II) from the unit deployment list. The UMO forwards the plan to the installation transportation office or MCT who validates the plan. Once validated, the installation transportation office or MCT orders the rail cars. See ATP 3-35, *Army Deployment and Redeployment,* and AR 525-93, *Army Deployment and Redeployment* for more information on the UMO's duties and responsibilities.

UNIT MOVEMENT COORDINATOR

C-3. The unit movement coordinator (UMC) provides unit movement planning, movement data reporting, data input training, and deployment planning and execution assistance to the UMO. The UMC assists the UMO with preparing the load plan in the Transportation Coordinator's – Automated Information for Movement System II, rail and equipment inspections, and execution of the rail load plan.

ACQUISITION

C-4. Rail cars, whether commercially owned or part of the Defense Freight Railway Interchange Fleet (commonly known as DFRIF), are sourced through the Military Surface Deployment and Distribution Command Fleet Manager by the installation transportation office or MCT. Units requiring rail cars should work with and through the installation transportation office or MCT.

PREPARE

C-5. Planners should survey the rail load site when possible to determine what support will be required. This will assist in developing a plan that allows for coordinated loading or unloading with minimal frustration. Planners should consider the serviceability of loading ramps, site layout, flow of traffic, and additional support or equipment needed to load the rail cars.

SITE CONSIDERATIONS

C-6. Logistics planners should consider the following during the site survey:

- Command and control facilities, warming tents, rations and beverages, communications, and medical treatment facilities.
- Equipment staging area.
- Maintenance support area.
- Generators and light sets.
- Material handling equipment.
- Radio Frequency Identification interrogators, if applicable.
- Disconnection of power to overhead electric wires, if applicable.
- Site security.

MATERIAL CONSIDERATIONS

C-7. The unit logistics planner coordinates material support for the unit, either through internal logistics units or in coordination with external agencies. As part of the logistics preparation, the planner should consider—

- Blocking, bracing, packaging, crating, and tie-down material.
- RFID tags for vehicles and equipment.
- Spanners.
- Material and container handling equipment.
- A crane capable of lighting the heaviest equipment items, either on site or on call.
- A wrecker capable of moving the heaviest vehicles.

Hazardous Materials

C-8. The unit hazardous material certifier must clearly identify, placard, segregate, pack, and certify all hazardous cargo on DD Form 2890 (*DoD Multimodal Dangerous Goods Declaration)* in accordance with CFR 49. The unit hazardous material certifier must prepare multiple copies of DD Form 2890 for each shipment of hazardous cargo and must accompany the unit equipment as it processes through the transportation inspection point. The unit hazardous material certifier will place one copy to the inside of a container, affix one copy on the outside of the container in a plastic sleeve to protect from inclement weather, one copy for the UMO's records, and one copy to the UMC. The unit hazardous material certifier will coordinate timelines with the ITO and UMC upon notification of the planned rail movement.

INSPECTION

C-9. The UMO and UMC conduct an inspection of rail cars with the railroad representative. In general, this inspection is looking at the general serviceability and correct selection of rail cars for the given equipment sets. As part of this inspection, the UMO and UMC should—

- Ensure flatcar decks are free of foreign matter or residue from pervious use.
- Ensure chains are present and serviceable on flatcars that are so equipped.
- Ensure that all wood decking is intact and serviceable.
- UMC provides the rail representative with the plan for spotting the cars.
- UMC requests car brakes to be applied and trucks chocked as the cars are spotted.

PRE-OPERATION CHECKS

C-10. Prior to conducting rail load operations, the unit commander, designated unit leaders, UMO and/or the load team officer in charge (OIC)/noncommissioned officer in charge (NCOIC) conduct pre-operations checks to ensure the unit's equipment and personnel are ready. At a minimum, considerations during these checks should include but are not limited to—

- Ensuring proper preparation of equipment for transport.
  - Packaging.
  - Hazardous material compatibility.

  - Shipping documentation.
  - Securing secondary loads.
  - Reducing oversized loads.
  - Weight distribution.
  - Placement of labels, placards, and RFID tags.
- Checking all vehicles to ensure shackles and pins are attached and serviceable.
- Checking fuel levels on all vehicles, generators, and trailer mounted equipment IAW rail servicer's requirements.
- Ensuring all wheeled vehicle tires are inflated to required standards.
- Ensuring all cargo is within height and weight restrictions as determined by Army, local government, or carrier regulations or policy.
- Inspecting blocking and bracing materials.
- Sequencing vehicles in the staging area for loading.
- Ensuring all personnel are properly licensed or certified for their assigned duties.
- Ensuring security is established.
- The unit commander conducts a risk assessment and implements appropriate mitigations before beginning operations.

LOAD TEAM BRIEF

C-11. Prior to the execution of rail load operations, the load team OIC or NCOIC will brief unit personnel on the rail head scheme of movement, the general order of the rail load operation, and any special safety considerations for the given operation and terrain.

EXECUTE

C-12. The rail load team are those personnel tasked with executing the rail load plan. This team should include an OIC or NCOIC, vehicle operators, mechanics, and any other supporting personnel identified during the planning phase. This team is responsible for the safe operation of vehicles in the staging yard, emplacement of spanners on rail cars, and verifying all vehicles and equipment are properly tied down and secured to the rail cars. Rail load operations are complete with a final inspection by the rail team OIC or NCOIC to inspect the load.

ASSESS

C-13. Upon completion of rail loading, the rail load team OIC or NCOIC, UMO, and UMC conduct a final walkthrough inspection with the designated railroad representative. The purpose of this inspection is to confirm overall suitability of the rail load for travel. This final inspection prior to movement —

- Verifies all vehicles and containers are chocked or blocked and tied down in accordance with applicable standards.
- Confirms weight limits are not exceeded.
- Verifies the height and width of all vehicles and containers is within the clearance limits of the designated route.
- Verifies the loads are evenly distributed.
- Confirms cargo escorts are provided, if required.
- Verifies all shipping labels and/or RFID tags are intact.

C-14. Once the last train departs the rail head, unit staff or a designated support unit coordinates for closure of the rail head. If the rail head is to remain open or will be used for follow on operations, the unit staff coordinates for proper transition of rail yard responsibility.

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Appendix D

Rail Dispatching Operations and Procedures

Rail dispatching operations and procedures in a theater of operations differ from that on commercial railroads. In a theater, trains used for military purposes such as troop transport, casualty evacuation, and ammunition resupply, must be given a higher priority. On a commercial railway, these types of trains would never have to be taken into account. Dispatching may become increasingly complex if passenger train service in the HN is continued. U.S. Army rail personnel who are in an advise or assist role with HN personnel and organizations will most likely operate under the HN's standard operating procedures. However, the procedures found in this appendix are historical examples that were utilized by U.S. Army rail organizations of the past and may be used as an example or as an educational tool.

DISPATCHING OPERATIONS

D-1. The method of dispatching trains may undergo radical changes. Enemy forces may attempt to disrupt operations with the destruction of trackage, bridges, signals, and other facilities. Rail operations must then be restored as quickly as possible, even if that service is severely degraded. For example, what may have been a double-track, high-speed road with automatic block signals, may become a single track with restricted speed and an improvised signal system. Dispatching becomes more difficult and complex as single-track operations prevail. Light trains carrying less tonnage at lower speeds may become the standard. Circumstances will determine the movement priority.

D-2. Dispatching trains on a busy section of railroad is one of the most exacting tasks in the transportation field. The train dispatcher (or HN equivalent) assists the chief train dispatcher (or HN equivalent). The train dispatcher must be able to make instant decisions with no margin for error. They have the same authority over train movement as the chief train dispatcher. They must know the exact physical layout of the main track in their division. They must also know the capabilities of the various types of locomotives in use. They may also be required to judge the capability of individual locomotives only by their number designators. They must also be familiar with the engineer's ability to get their trains over the road.

DISPATCHING ON HIGH SPEED VERSUS LOW SPEED TRACK

D-3. Some railroads make a strict distinction between the standards of low-speed and high-speed track. On the low-speed track, lighter rail is used, less ballast and subballast maintenance is performed, and tie renewal is considered less often than on the high-speed track. The tracks are designated either freight or passenger, and trains are interchanged only in emergencies. Continued operation of heavy freights over passenger tracks require constant maintenance work to keep them in the condition required to give maximum riding comfort.

D-4. Many railroads make no distinction between the standards of the low -speed and high-speed tracks. The weight of the rail is identical, and the ties and subgrade are the same. The terms "high speed" and "low speed" may be used to describe these tracks, but the timetable would refer to them simply as numbers 1, 2, 3, 4, and so forth. A train would generally only run against the flow of traffic if both tracks in one direction were blocked or otherwise rendered unusable.

DISPATCHING PERSONNEL

D-5. Railroad main line operations are complex, involving the movement of freight, passenger, and mixed (freight and passenger) trains from one terminal or yard to another over a division or subdivision of track.

Competent dispatch personnel are needed in order to ensure these coordinated operations are successfully accomplished.

CHIEF TRAIN DISPATCHER (CHIEF DISPATCHER)

D-6. The ***chief train dispatcher*** **supervises train movement, reroutes rail traffic in emergencies, determines train tonnage, orders motive power, determines rail line capacity, and establishes train movement priority.** Also known as the chief dispatcher, they are in charge of the dispatch office. They initial all orders, messages, and instructions. In any matter affecting main-track operations, they act as the superintendent.

D-7. The ERC may benefit from providing an LNO to the railroad dispatch center. LNOs will provide in-transit visibility to the ERC HQ when developing data for a common operating picture.

ASSISTANT CHIEF DISPATCHER

D-8. The assistant chief dispatcher may be assigned at a division terminal. An assistant chief must be qualified to assume responsibility of the chief train dispatcher. They must also be qualified to assume responsibility of any train dispatcher working in the particular office, on shift, or in emergencies. A large portion of work may be devoted to processing accident reports and in preparing train delay reports. The office train master or superintendent uses these reports. They do other related work as prescribed by the chief dispatcher.

TRAIN DISPATCHER

D-9. A ***train dispatcher*** **is responsible for main-line movement of passenger and freight trains on a division.** Also known as the dispatcher, their objective is to get scheduled trains from one end of the division to the other according to published timetables or train orders. They must also get extras (unscheduled trains) over the track in the briefest (but safest) possible time.

CAR DISTRIBUTION CLERK

D-10. The car distribution clerk maintains visibility for all railcars (including loaded or empty cars) in the division area. The car distribution clerk will compare the car requirements for loading with the location of empty cars and will prepare the documentation for redistribution of railcars as desired. They will also report any delays in car unloading to the chief train dispatcher.

D-11. The car distribution clerk totals the number of empty cars shown on the various yard reports and enters them on the consolidated empty car report. The forms for this report are not only different among railroads but also between civilian and military railroads. As empty cars move out of a yard, the car distribution clerk deducts them from the master report. The next report from the yard omits those moved but includes others accumulated since the previous report. A report from a yard often does not change greatly from its previous one. The principal change is in the figures for sorted and unsorted cars.

TIMETABLE

D-12. A timetable (as discussed in chapter 2) authorizes the movement of scheduled trains. Designators in the timetable show train superiority. First-class trains are superior to all other class-designated trains. Extra or unscheduled trains are inferior to all regular trains having a class designator. No superiority or inferiority exists between extra trains. The timetable on a single track also specifies the superior direction. Division timetable pages dealing with schedules appear similar to those in the timetables furnished to the traveling public. The two timetables should not be confused because the division timetable contains much greater detail. You could use the division timetable as a supplementary book of rules to amend, supplement, extend, and even interpret many of the standing operating rules.

D-13. When schedules are worked out for publication in a single-track timetable, the meets of scheduled trains are planned so train orders are unnecessary. However, scheduled trains may often run late. When they

do, train orders must be issued to other trains on the line to assist the overdue trains in getting back on schedule or to prevent them from delaying other trains or operations.

Running Ahead of Schedule

D-14. The right of a regular train to occupy the main track at a particular time is established in the timetable. The train must travel in strict accordance with the published time figures in the train schedule. A train cannot gain time en route and arrive at the various stations before it is due. A train may gain time between any two successive stations, but it must not pass the advance station earlier than the time shown in the timetable. When yard crews desire to cross (or foul) main tracks, or when an inferior train occupies a track ahead of a superior one, crews must adhere strictly to the published time figures in the timetable. Yard crews must never operate on or across main tracks (unless within yard limits) without the authority of the train dispatcher.

Running Behind Schedule

D-15. When a train becomes late according to its schedule, the result is many other delays to inferior trains running over the division. Likewise, yard engines required to use or cross the main tracks in doing their work may also be delayed. When a regular train becomes late, the train dispatcher must be cautious in authorizing movements that might interfere with its progress and efforts to get back on schedule. The dispatcher would likely have no way of knowing how many minutes the engineer may have gained since they reported past the last station. If the dispatcher takes no positive action, the crews on the division must respect the published time until they are otherwise directed by a train order.

LOSS OF TIMETABLE SCHEDULE

D-16. On occasion, a scheduled train may lose its right and its schedule. With a loss of schedule, the train loses its right to continue occupying the main track. Loss of schedule and restricted superiority are entirely different events and distinction must be clearly understood. A train may have its timetable superiority temporarily suspended by a train order. This suspension puts restrictions on the train. These restrictions are only temporary and the train continues on its normal schedule after the train order is fulfilled. However, on two occasions the train actually loses its schedule and therefore, its superiority.

More Than Twelve Hours Late

D-17. When a scheduled train becomes more than 12 hours late, it is said to "die on its schedule." A train will die on its schedule if it arrives more than 12 hours late at a scheduled station or departs more than 12 hours late. This means that it has lost its schedule and that all train orders, if it holds any, are annulled. The train can proceed from the point where it lost its schedule only on new train orders from the train dispatcher. In either event, the dispatcher would have to recreate the train as an extra or run it as a section of another scheduled train. Loss of schedule should not be a common occurrence because some positive action should be taken to assist a train or annul its schedule before it becomes 12 hours late.

Change of Timetable

D-18. A train may lose its schedule because a new timetable is issued. When a train is late and is going to overlap a new timetable, the train’s schedule must be annulled and recreated as an extra.

SUPERIORITY AND RIGHT

D-19. "Right" as a train dispatcher uses it, can be conferred by train order alone. ‘‘Superiority‘‘ is granted by the timetable based on a train’s superior class or superior direction. A regular train may have timetable authorization or timetable superiority, but not necessarily superiority by right. In single- track operations (see chapter 2), a train is generally superior to another train by right, class, or direction—with right being superior to class or direction. Direction is superior between trains of the same class. In double- track operations, a train is generally superior to another train by right or class—with right being superior to class. Direction is not significant in double-track operations since each set of tracks would normally carry traffic in the opposite

direction. Direction is a factor in single-track operations since trains can travel toward each other on the same track.

D-20. Class is conferred by timetable and cannot be raised or lowered by train order. Class can be taken away by annulling the train schedule and running the train as an extra. Extra trains are inferior to all others. On most railroads, when two extra trains meet on a single track, the train moving in the superior direction holds main track, while the other takes siding.

ORDERS AFFECTING SCHEDULED TRAINS

D-21. A run-late order has the same effect as changing the published train schedule for the particular trip. It sets back the schedule by as many minutes as the train is late. In handling late trains, the train dispatcher has the following three options:

- Give the crew a run-late order to run late from origin to destination.
- Issue no restricting orders and permit the crew to make up as much of the late time as possible.
- Give the crew a wait order, which would specify the earliest time the train could depart the stations shown in the wait order.

D-22. A run-late order does not help the late train order because it does not permit the train to make up any of the lost time. However, a run-late order may be helpful to an inferior train. When a dispatcher issues a run-late order, they are amending the timetable schedule (called "putting out time") for that particular train for that particular trip. Therefore, the dispatcher is granting others the use of the time represented by the difference in minutes between the advertised and the run-late time. If the dispatcher takes no train-order action, the delayed train would be free to make up some of the time. However, other trains and yard crews would not know the precise time to expect the train, and they could not depend on using the full lost time because this figure might be progressively reduced as the train travels over the division. Issuing a run-late order guarantees to all concerned that the amount of lost time will not be reduced.

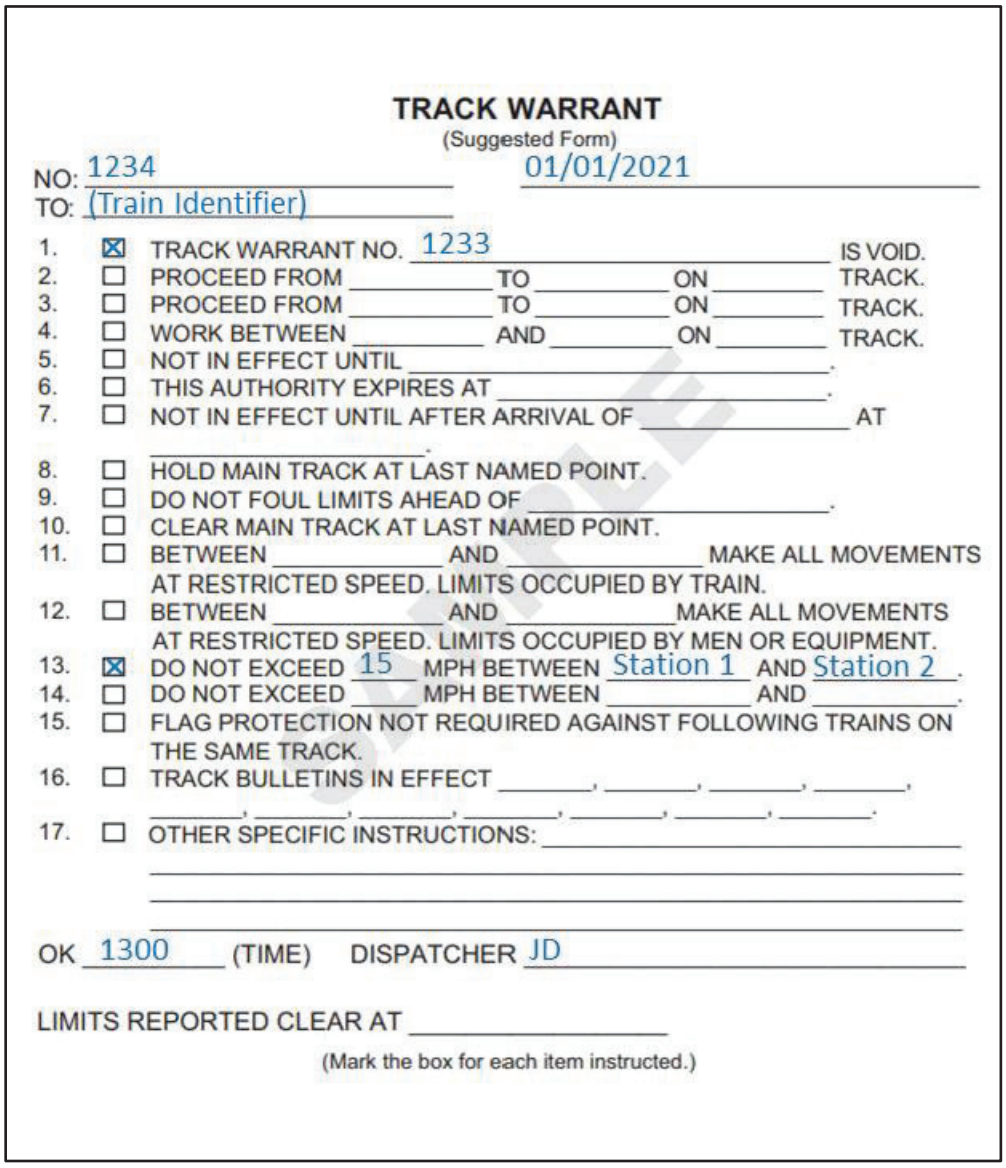
D-23. A wait order, also called a time order, may be issued instead of a run-late order. It is not popular with all train dispatchers and some railroads prohibit its use. A wait order permits the engineer to make up time and tells everyone concerned about how much time will be made up. The order permits a train to make up a specified number of stations, but the train may not leave a station before a stated time. A new schedule is written for most of the run. In effect, the wait order shortens the individual running time between certain stations.

TRAIN REGISTERS

D-24. When a train prepares to leave its starting point, the crew has no way of knowing whether all superior trains have arrived and departed. The crew also has no way of knowing whether any superior trains that have passed were displaying signals for following sections. In some areas, the train dispatcher advises a crew by an order of the superior trains for which they must wait before going out on the main track. At other areas, train registers are kept to furnish this information for all concerned. When a train arrives at a station where it has work or when it reaches a junction point, the conductor signs the register. The conductor writes in the number, class, arrival time of their train, and the type of signals it is displaying (if any). Just before the train leaves, the conductor checks the register for other arrivals or departures that may be superior and then enters their departure time. Extra trains generally having no stops where the register is located are not stopped simply to register. Timetables of most railroads provide that extra trains may register without stopping. Instead, the crew throws off a message containing the necessary information and the operator enters it in the train register.

TRACK WARRANTS AND BULLETINS

D-25. The following rules pertain to those orders and instructions governed by track warrants and bulletins. These rules are applicable only within track warrant control limits. See figure D-1 for a suggested track warrant format.



TRACK WARRANT

(Suggested Form)

NO: 1234 01/01/2021

TO: (Train Identifier)

1. ☒ TRACK WARRANT NO. 1233 IS VOID.
2. ☐ PROCEED FROM _____ TO _____ ON _____ TRACK.
3. ☐ PROCEED FROM _____ TO _____ ON _____ TRACK.
4. ☐ WORK BETWEEN _____ AND _____ ON _____ TRACK.
5. ☐ NOT IN EFFECT UNTIL _____.
6. ☐ THIS AUTHORITY EXPIRES AT _____.
7. ☐ NOT IN EFFECT UNTIL AFTER ARRIVAL OF _____ AT _____.
8. ☐ HOLD MAIN TRACK AT LAST NAMED POINT.
9. ☐ DO NOT FOUL LIMITS AHEAD OF _____.
10. ☐ CLEAR MAIN TRACK AT LAST NAMED POINT.
11. ☐ BETWEEN _____ AND _____ MAKE ALL MOVEMENTS AT RESTRICTED SPEED. LIMITS OCCUPIED BY TRAIN.
12. ☐ BETWEEN _____ AND _____ MAKE ALL MOVEMENTS AT RESTRICTED SPEED. LIMITS OCCUPIED BY MEN OR EQUIPMENT.
13. ☒ DO NOT EXCEED 15 MPH BETWEEN Station 1 AND Station 2.
14. ☐ DO NOT EXCEED _____ MPH BETWEEN _____ AND _____.
15. ☐ FLAG PROTECTION NOT REQUIRED AGAINST FOLLOWING TRAINS ON THE SAME TRACK.
16. ☐ TRACK BULLETINS IN EFFECT _____, _____, _____, _____, _____, _____, _____, _____, _____, _____, _____, _____.
17. ☐ OTHER SPECIFIC INSTRUCTIONS: _____

OK 1300 (TIME) DISPATCHER JD

LIMITS REPORTED CLEAR AT _____

(Mark the box for each item instructed.)

Figure D-1. Example Track Warrant Format

AUTHORITY

D-26. Where designated by special instructions or general order, use of the main track will be authorized (under the direction and over the signature of the train dispatcher) by issuance of a track warrant. Track warrants are numbered consecutively from the beginning of each calendar date. Within track warrant control territory, there is no superiority of trains and trains will not be authorized by train order or timetable schedule.

DESIGNATED LIMITS

D-27. The limits of a track warrant are designated by specifying the track, where required, and exact points such as switches, mile poles, or identifiable points. Station names may be used. When a station name is used to designate the first named point, the authority will extend from the last siding switch or from a station sign if there is no siding.

D-28. When a station name is used to designate the second named point, the authority extends to the first siding switch or to the station sign if there is no siding. At the second named point, authority extends to the last siding switch when specific instructions include "hold main track at last named point."

REQUESTING

D-29. Personnel requesting a track warrant must advise the train dispatcher of the movements to be made and, when applicable, the tracks to be used and time required.

COPYING

D-30. The conductor and the engineer must have a copy of the track warrant addressed to their train or engine. The track warrant will show the date, location, name of person who copied it, and any specific instructions issued. All information and instructions are entered on the track warrant form provided and repeated to the train dispatcher. The dispatcher will check the copy and, if correct, will give an "OK" and the time. The OK time is entered on the track warrant and repeated to the train dispatcher. The track warrant is not considered in effect until the OK time is shown on it. If the track warrant restricts movement or authority previously granted, it is not considered in effect by the train dispatcher until acknowledgement of the OK has been received. Track warrants are relayed by authorized personnel, who must then record the message on a track warrant.

DESIGNATION OF TRAINS

D-31. In track warrants and track bulletins, trains are designated by engine number and direction when applicable. When an engine of another company is used, it is designated by the initials or name of the company preceding the engine number.

MECHANICAL TRANSMISSION

D-32. At points designated by special instructions, track warrants and track bulletins may be transmitted mechanically. When so transmitted, repetition will not be required. OK time will be given at the time transmitted and the name of the train dispatcher will be shown in the space provided for name of copying personnel. Track warrants restricting the authority or movement of a train must not be sent in this manner unless it is known that the train being restricted will not leave the point without receiving the track warrant. Special instructions will prescribe how track warrants and track bulletins are to be delivered at these points.

SPECIFIC INSTRUCTIONS

D-33. Track warrants will include specific instructions that must be complied with by those addressed. Each track warrant must be given in the same words to all personnel addressed. Once in effect, the track warrant must not be added to or altered in any manner except as discussed in appendix C.

CHANGING TRACK WARRANT

D-34. When a track warrant is in effect and the limits or instructions are changed, a new track warrant is issued with the instructions and will include the words "Track Warrant No is void." When a track warrant of a previous date is voided, the date must be included. The previous track warrant will no longer be in effect.

OPERATING WITH TRACK WARRANT

D-35. A track warrant authorizes the train or engine addressed to occupy the main track within designated limits. The train must not foul (or block) a switch at either end of the limits that may be used by an opposing train or engine to clear the main track. Movement must be made as follows:

- When authorized to proceed from one point to another, movement is authorized only in the direction specified.
- When authorized to work between two specific points, movement may be made in either direction between those points.

OCCUPYING SAME LIMITS

D-36. Not more than one train or engine is permitted to occupy the same or overlapping limits of a track warrant at the same time, except in the following circumstances:

- All trains or engines within the limits have been authorized to move only in the same direction and are required to provide flag protection.
- Two or more crews performing switching or work service have been notified of each other and instructed that all movements must be made at restricted speed within the overlapping limits.

IN EFFECT

D-37. A track warrant is in effect until a crew member reports the train clear of the limits, the warrant becomes void, or the time limit expires. The crew member must report to the train dispatcher when they have cleared the limits. If a time limit is shown on the track warrant, a train or engine must be clear of the limits by the time specified, unless another track warrant has been obtained.

MARKING VOID

D-38. The word VOID must be written legibly across each copy of the track warrant when a crew member has reported the train or engine clear of the limits, the time limit specified has expired, or the track warrant has been changed.

PROTECTING MEN OR MACHINES

D-39. A track warrant permitting men or machines to occupy or perform maintenance on main track without other protection is issued in the same manner as that for trains or engines.

D-40. A track warrant must not be issued to protect men or machines within the same or overlapping limits with a train or engine, except in the following circumstances:

- All trains or engines authorized to occupy the same or overlapping limits have been authorized to move in one direction only and the track warrant specifies that it is granted behind such trains or engines.
- Trains or engines authorized to occupy the same or overlapping limits have been notified of the authority granted to the men or machines, have been instructed to make all movements at restricted speed and have been instructed to stop short of men or machines on or fouling track. The person in charge of maintenance must be so notified by a track warrant. If track is not safe for movement at restricted speed, personnel in charge must protect such track by placing red flags.

MOVEMENT AGAINST THE CURRENT OF TRAFFIC

D-41. When a track warrant authorizes movement against the current of traffic, the train or engine must use only the track designated within the limits specified.

EXTRA TRAINS

D-42. An extra train is a train not designated by timetable. These trains are designated as extra, extra passenger, and extra work trains. Since extra trains are not authorized by timetable, they are identified by the number assigned to the locomotive pulling the train. For example, when locomotive 310 is used to move a train eastward, the train is numbered "Extra 310 East" or "Work Extra 9220."

WORK TRAINS

D-43. Work extras are work trains from which personnel perform track maintenance and construction along the right-of-way between specified points. Since these trains move in both directions, no directional designator is used when referring to them. Unless provided in a train order, a work extra must clear all regular trains and protect against other extras in both directions. A work extra may not protect against a regular train; that is, work on the time of an overdue scheduled train under flag protection unless instructed to do so by a

train order. A train is protected when the crew stations a flagman adequately ahead or to the rear of the stationary train to stop any approaching train. Since work trains are almost always stationary, it is practical to have them protect themselves against all trains. Work trains are located fairly close to a siding so that they can enter the siding to clear the main track as another train approaches. The work train's conductor ensures that their train clears all regular trains as specified by the rules. When a wayside dispatcher telephone is near, the conductor maintains almost constant contact with the train dispatcher regarding the approach of extras. A work train that occupies a main track has a flagman who must flag the main track to alert any approaching train. They are relieved from flagging only when the train clears the main track. A number of blasts sounded on the locomotive's whistle signals the track is clear.

WORK TRAIN ORDERS

D-44. When a work train must frequently move back and forth, it is impractical to have the flagman walk ahead of the train. The train dispatcher, knowing the kind of work being done and the extras moving in the area, may issue an order that permits the work train to move unhampered. If no extra is to arrive at the work limits before a specified time, the dispatcher may issue a train order that will permit the maintenance personnel to carry out their tasks without protecting the extras until that time.

PROTECTING AGAINST WORK TRAINS

D-45. Trains of superior class do not protect against work trains. On double track, all operating crews know the location of the work train's work area. Notices posted in crew offices along the line specify the work area, the number of days the work will be in progress, and a reduced-speed limit for the area. On single track, all trains in each direction are given copies of the work extra's train orders. Instructions generally require all work extras to clear the trains without delay. However, no approaching train, regardless of superiority, tonnage, or importance will run past a work train flagman.

MILITARY WORK TRAINS

D-46. In a theater of operations, it may be necessary for all trains to protect against work trains, signifying that the work train has a higher priority than the trains hauling troops or supplies. In civilian practice, a work train may be in a particular location to do work solely to improve passenger comfort or to make long-range repairs necessary to protect capital investment. Under these conditions, it is much more economical for a work train to protect against and clear the time of all trains. A military work train may be found blocking the main track because of more pressing reasons. In a theater, passenger comfort and long-range maintenance are not main priorities. Work trains operate only when absolutely necessary to keep trackage reasonably fit for supply and troop trains. Failure to do track work quickly could result in a blockage in which no trains would be able to move.

PROPER WORK TRAIN FLAGGING

D-47. Work train flagging is almost impossible to over-emphasize. When the train is on the main track, the flagman protects its rear by stationing himself far enough back to stop any approaching train. On single-track lines, the forward end of the train must be protected in a similar manner. When the work train pulls into a siding and clears the main, an appropriate number of blasts are sounded on the whistle. This is called "whistling in" the flagman. Before the train again blocks the main, a specified number of blasts are sounded and the flagman goes out to flag. This is called "whistling out." The number of blasts varies according to the direction in which the train is headed and to the number of main tracks. The alternate whistling in and whistling out, which occurs when a train clears and blocks the main, involves a hazard that operating rules do not stress and one that safety spokesmen seldom point out. The danger that occurs during flagging is that the flagman may forget whether they are on the main track or in the siding. To keep track of their position, the flagman maintains radio contact with the work train conductor.

SECTIONS

D-48. Running additional sections are often necessary when handling passenger trains. A section is one of two or more trains running on the same schedule. Technically speaking, there is no such thing as a passenger

train. A train either has a class designator or it is an extra. While it appears logical that if there are no passenger trains, there could be no extra passenger trains. Some railroads require all trains be designated by class or extras. Other railroads recognize the need for the extra passenger train designation and use it for trains that cannot be run on another train's schedule. This designator receives more respect from yard crews and from crews of trains of equal class. However, crews of scheduled trains must regard the extra passenger as inferior to their own.

D-49. The train dispatcher, when required, could authorize an additional train and call it a section. To give this section first-class standing, the dispatcher can run it as a continuation of a first-class scheduled train and call it a "second section." The dispatcher can give this section right over other trains that would otherwise be superior by calling the section "Second 87" or some other train number. By doing so, the regular train becomes "First 87." Both trains would receive train orders, and the engine of the first section would have to display signals for another section.

CENTRALIZED TRAFFIC CONTROL

D-50. Operating a rail division controlled with centralized traffic control (CTC) is much simpler than operating by the other methods. The train dispatcher merely flips a switch on the CTC panel. The switch opens a yard switch and lights a proceed signal for the train. The dispatcher does not advise the train crew of their plans and written orders are not necessary. Tracks have signals facing in each direction and there is no established flow of traffic in CTC-controlled areas. This gives the dispatcher complete flexibility of train movement. The dispatcher may run trains on any track in either direction. Regardless of the class of a train, it can continue to move against or ahead of trains of a superior class as long as a signal tells it to do so.

D-51. The CTC system eliminates reading, repeating, interpreting, and remembering the provisions of many train orders that would ordinarily be received. The crew receives visual orders from the signal lights at the time and point where they are to be executed.

D-52. Many foreign railroads use electric interlocking (an early form of CTC). The layout may extend for several kilometers on each side of the control tower from which the interlocking plant is operated by a towerman. However, the towerman's control ends where the tracks join the area under the control of the dispatcher. Generally used at congested junctions and terminals, such installations allow the dispatcher and the tower operator more flexibility in handling trains and yard movement in yard limits.

D-53. The dispatcher's control panel or board has diagrams representing the track layout. All areas under the dispatcher's jurisdiction controlled by CTC are shown on the panel. Small indicators, mounted at intervals along the board, light up as the train reaches the point on the railroad represented by each particular indicator. A train dispatcher can watch the progress of any train within their jurisdiction merely by observing the lights. They can also check the speed of a train by timing it between two lights. The dispatcher knows when a train makes an unscheduled stop or when it is losing time. The engine crew never knows its exact path of travel until a short distance before reaching a point of divergence. Reduce-speed signals are displayed in advance of a change of track to give an engineer time to slow down. The engine crew relies on the permissive and restrictive aspects of the signals automatically displayed when the dispatcher opens or closes the switches.

D-54. The CTC system has a safety feature that makes it impossible for a train dispatcher to suddenly take away a permissive route for a train after the engineer comes in sight of the signal. Although the dispatcher can take away the displayed permissive signal and flash a restrictive signal "in the face" of the crew, the switches controlling the track route cannot change if the engineer lacks enough time to comply with the change signal. The system is wired so the dispatcher cannot set up conflicting moves. Single-track installations are connected so that if a train fails to make a stop specified by a signal, other signals in advance of the train are automatically displayed to stop a train that may be approaching on the same track from the opposite direction.

D-55. CTC is used mainly on single-track sections. Some railroads have converted double-track sections to a single-track layout. The results have been reduced maintenance-of-way costs and accelerated freight train schedules. Using CTC often permits an increase in TD because the delay caused by wait-and-meet orders is reduced. With CTC, a dispatcher is often able to get two trains by a given point without stopping either one. This is done by keeping one moving through a siding while the other passes on the main track. If a siding is

long enough, or if a single track branches for several kilometers into a double track, a dispatcher may also have a train pass another in the same direction without reducing the speed of either.

Appendix E

Main Line Operations and Procedures

Main line operations and procedures are complex. They involve the movement of freight, passenger, and mixed (freight and passenger) trains from one terminal or yard to another over a division or subdivision of track. This appendix contains U.S. railroading operations and procedures, and historical examples of operations and procedures that U.S. rail units utilized in the past. Some of these procedures are obsolete, however, they may be useful in advising and assisting a HN rail organization.

TRAIN OPERATING COMPANY PERSONNEL

E-1. In the past, the train operating company of the transportation railway battalion provided crews for operating locomotives and trains in military railroading. Today, the ERC and the railway planning and advisory teams will advise and assist local HN or contracted crews to operate either freight or passenger trains over a main line or engines in rail yards. Certain terms are used to distinguish between crews in U.S. railroading. Use of the terms "yard crew" and "road crew" refers to the crew's place of employment. The term "ground crew" applies to a conductor and their brakemen.

E-2. An American road crew normally consists of the following:

- Conductor.
- Engineer.
- Brakeman.

E-3. If steam motive power is used, a fireman will be added to the crew. In the past, there were two brakemen, a senior brakeman and a brakeman. One of the two brakemen normally assigned accompanied the engine or rides the train near the head end. This brakeman was known as the forward or head brakeman. The other brakeman was permanently assigned to rear-end flagging duties. The rear brakeman was known as the flagman. A third brakeman may have been assigned when the work load demanded their service. The engineer and the fireman (if one is assigned) are called the engine crew. The rest are known collectively as the train crew. The conductor is in charge of the full crew (both trainmen and enginemen).

E-4. Military railroads in theaters of operations often need armed security guards to accompany a train to help protect shipments against pilferage. Such personnel are not a part of the crew. In addition, all personnel should have their individual protective equipment with them during main line operations.

CALLING AND REPORTING

E-5. When a road crew is called for duty, each member should receive a written or a verbal notice giving the time called, the train's destination, and its type or symbol number. Depending on the distance they are from their duty stations, crews receive notice from 1 to 2 hours ahead of the time they are called for work.

E-6. Upon reporting for duty, crew members sign a register and read and sign an acknowledgment of any newly posted general orders or bulletins that may affect operations over the portion of railroad their train will travel. They are told the engine number for the trip. Crew register offices have standard clocks with which all crew members must synchronize their watches. The conductor retrieves the track number the train is on and what track the road engine is to use to go to that track from the yardmaster.

TRAIN CREW DUTIES

E-7. The locomotive engineman (or engineer) operates the locomotive and runs the train according to the following:

- Operating rules.
- Timetable.
- Train orders.
- Other general notices or directives.

E-8. Although a locomotive located "first out" on a ready track is practically guaranteed to operate properly, the engineman should inspect the fuel, sand, water, and lubricating and valve oil. The engineman and the head brakeman move the locomotive or road engine from the ready track to the departure yard. A hostler is a person who moves engines around yards and enginehouse areas. On some railroads, a hostler may take the engine from the ready track to the yard track.

E-9. The brakemen line switches at their respective ends of the train. They couple and uncouple cars, connect and disconnect air hoses, set hand brakes, and relay hand signals (as does the conductor). The brakemen also take every opportunity to inspect the train for malfunction of equipment or shifting of cargo.

E-10. The senior or head brakeman gives signals (by hand, lantern, flag, or verbal orders) for the movement of trains. The head brakeman should ride on or near the engine for the entire trip and do all front-end flagging. They repeat signal aspects as the engineman calls them to ensure that concerned personnel are reading them the same way. The head brakeman observes trains for any errors that may be displayed in signaling.

E-11. When the head brakeman and engineman take a road engine from the ready track, they bring it to the departure yard and back it against the train. After the engine is coupled to the first car of the train, a road test should be made of the air brake system. Signal flags identifying the class of the train are mounted when required.

E-12. The flagman checks the flagging equipment (which includes flags, fuses, torpedoes, and lanterns with red and white lights). They mount the marker lanterns, disks, or flags on the rear car to give the train official standing, after it is on the main line.

E-13. The conductor is responsible for the whole train. The conductor compares watches with the engine crew and briefs them on the orders they hold and the work they will do en route. The conductor reports to the yard office for waybills and train orders governing their trip on the main line. The conductor performs the following at the yard office:

- Checks the waybills against the train consist.
- Prepares the wheel report.
- Supervises the disposition of cars set off.
- Surveys accidents or mechanical failure of equipment (including reporting damages or delays).
- Ensures the correct placement of HAZMAT and high and wide efficiency cars

E-14. The conductor, along with the other crew members, observes signals from towers, stations, and from other trains. The conductor receives and acts on any additional train orders en route. The engineman will not move the train until they receive the signal from the flagman to depart. When the train leaves the yard and enters the main line, the train dispatcher controls its movement. However, the conductor must see that their train runs according to operating rules and that it does not run ahead of time.

E-15. If the train is not a through train, the conductor will usually make a penciled lineup and call the train dispatcher regarding setoffs en route. The dispatcher may tell the conductor what stations have pickups for the train. If both telephone and dispatcher circuits exist, the conductor may call two or three stations ahead. When contacting a distant yardmaster or station agent, the conductor does the following:

- States what cars they have to set off and determines on which tracks they should be placed.
- Determines what cars will be picked up; the track number; and, if pickup will be some distance from the yard office, the location of the waybills and wheel report.
- Receives waybills or waybill modifications en route. When a train must pick up cars some distance from a yard office, the waybills may be delivered to the moving train by a message hoop to prevent the train’s stopping twice; if weighted and protected against bad weather, bills may be left on the end of the first car of the pickup.

- Asks the yardmaster where waybills should be left if the train is setting off cars some distance from the yard office; a yard receiving a setoff of only a few cars may station someone along the track to catch waybills thrown off the moving engine.
- Wraps bills securely around a rock or other heavy object to prevent the possibility of a vacuum drawing them under the car wheels.

LOCOMOTIVE INSTRUMENTS AND CONTROLS

E-16. The engine crew assumes the chief role in the safe and expeditious progress of a train on the main line. A number of locomotive controls are used to keep a train running smoothly, speedily, and safely. The objective of the engine crew is to take the train over the road safely in the scheduled time, using the least amount of fuel with minimum wear on the rail equipment.

E-17. The engineman's principal controls on a diesel-electric locomotive are as follows: Throttle lever that regulates the engine's speed. Reverse lever that controls magnet valves in the reverser. Independent and automatic brake valves that control the locomotive brakes only, and locomotive and car brakes, respectively.

DEPARTURE PROCEDURES

E-18. Before a train leaves the yard, the crew makes a road test of the air brake system. Upon coupling the locomotive to the train, the engineman starts the locomotive's air pumps to bring the trainline or brake-pipe pressure within not less than 5 pounds below the standard pressure prescribed for the train. When this figure is reached, the flagman signals the engineman to apply the brakes and to reduce pressure by 15 pounds on the brake-pipe gauge. This is called a service reduction. The amount of brake-pipe leakage must not exceed 5 pounds per minute as noted on the brake-pipe gauge. When the brakes are applied, it indicates the flow of air is uninterrupted on the entire length of the train. A signal is then given to release the brakes. After this test, the reduction must be increased to 25 pounds. If the brakes apply and release, it is assumed that they have performed the same on the entire length of the train. This assumption is based on the fact that car inspectors have previously made a terminal air test and have walked the entire length of the train to ensure the brakes have applied and released on all cars. If car inspectors are not on hand, a conclusive air test can be made by a crew member walking beside the train and observing each car. After the air test, and if train-line or brake-pipe leakage is within permissible limits, the train is ready to pull.

E-19. At the head end, the conductor will brief the head brakeman and engineman on the type of train and at what yards they will have setoffs and pickups. The conductor will advise the head brakeman how to handle waybills at each stop and will pass verbal orders from the train dispatcher. If there are many stops to be made or if instructions are involved, instructions may be given in writing. Waybills and sections of the wheel report for cars that will be set off en route are given to the head brakeman. Through waybills are kept by the conductor for additional clerical work.

AUTOMATIC SIGNAL SYSTEMS

E-20. Railway signals are devices, indicators, and signs that control the movement of trains along tracks and into and out of stations, terminals, and yards. These signals may be given by hand or by a complex, automatically operated electrical system. Signals may be fixed such as whistle posts, speed, and yard limit signs.

BLOCK SIGNAL SYSTEM

E-21. The block signal system permits faster train speeds than any other signal system. It is designed to maintain predetermined intervals between trains by means of the track circuits and appropriate electrical equipment activated by the trains. A section of track is divided into blocks; each block is governed by a three-position light or semaphore signal. An approach aspect displayed in each block indicates the situation in the next (succeeding) block. Therefore, each train is protected to its rear by a signal indicating the following train must proceed at restricted speed and be prepared to stop if the block is occupied. The system may be used on single- or multiple-track to control following or opposing trains. On single-track routes, controlled movement, from siding to siding, sustains opposing traffic flow.

CENTRALIZED TRAFFIC CONTROL

E-22. As discussed in greater detail in appendix C, CTC is a refinement of electric or pneumatic interlocking. This system permits the moving trains through an extended area (200 to 300 miles) over tracks and blocks controlled from a distant point. Train dispatchers have control over all switches and signals in the area. On a panel board or wall before them, they have an electrically lighted diagram that shows all locomotive or train locations, switch positions, and signal indications on the controlled sections of track. Using a control machine, they can change switch positions and signal indications as required.

INTERLOCKING PLANTS

E-23. Foreign railroads often use interlocking plants and/or switch towers. Conditions in a theater of operations seldom are stable enough to justify installation of new interlocking plants. However, if possible, existing plants should be used in areas of heavy traffic. Table E-1 contains a list of definitions that personnel should be familiar with in order to understand further discussion.

Table E-1. Definitions

Term	***Definition***
Control tower (interlocking station)	The place from which the interlocking plant is operated.
Interlocking machine	An assembly of manually operated levers or push buttons used to control mechanically or electrically operated lights, signals, switches, derailers, and other units.
Electric lock	A device which prevents movement of a lever, switch, or other moveable object until properly released.
Foundation	A fixed support for signal devices.
Lead out	Mechanical connections between the interlocking machine and outside equipment.
Pipelines	Connections made with pipe or tubing and the supporting apparatus leading from the operating lever to the operated unit.
Switch mechanisms	Fittings for equipping a switch.
Signals	Home, distant, and dwarf signals of an interlocking plant.

Operation

E-24. Interlocking plants may be operated manually, electrically, or electro-mechanically. The interlocking machine consists of a series of devices (so interconnected that they can be manipulated and operated only in a predetermined order) which control traffic from a central point by operating a series of signals and switches. Latches in the control levers activate interconnecting bars, crosslocks, and dogs that prevent incorrect order of operation. A lever in the machine or a button in the control panel regulates all signals and switches of that particular interlocking. The switches and signals are interlocked electrically and mechanically to ensure the proper signal is displayed for a specific route and that the switch points match the displayed aspects.

Location

E-25. An interlocking plant is centrally located in a large terminal or junction at a point of maximum visibility. Specifically, interlocking installations usually are found at the following locations:

- Entrance or exit of large freight and passenger terminals.
- Large receiving, classification, and switching yards.
- Railroad crossings for trains traveling in different directions or for trains of different railroad lines.
- Junctions with the main line.

Inspection and Maintenance

E-26. Since railway signaling equipment is complex and varied in design, concise instructions covering its maintenance and repair cannot be included within the scope of this ATP. Manufacturer's manuals contain

specific details of construction and design. In oversea theaters, these publications may not be available for the signal equipment that ERC personnel may encounter. Therefore, it may be difficult to advise and assist HN operators on this equipment if they do not possess the expertise themselves. But keep in mind, maintenance required is directly related to the quality and frequency of inspection. Constant, careful inspection and testing will greatly reduce maintenance requirements.

Safety Procedures

E-27. When defective elements or parts of a signal system are removed, the signal devices must be arranged to display the most restrictive aspects. Under no circumstances should agents, operators, or train personnel make any but the most minor repairs. Railway signal equipment is intended to provide the fastest train movement possible under safe operating conditions. If repair is not rigidly controlled, signal equipment deteriorates until it becomes unreliable and unsafe.

SIGNALS AND MARKERS

E-28. The three fundamental aspects to all railway signaling are: stop, caution, and proceed. The following describes the signals and markers used in U.S. railway operations.

FIXED SIGNALS

E-29. Fixed signals (figure E-1 on page E-6) are defined as any signals of fixed location that affect the movement of a train or engine. They may be in many sizes and shapes. The three basic fixed signals that are commonly found are semaphore, color light, and position light. Aspects of fixed signals are shown by the position of semaphore arms, color of lights, position of lights, or a combination of color and position of lights.

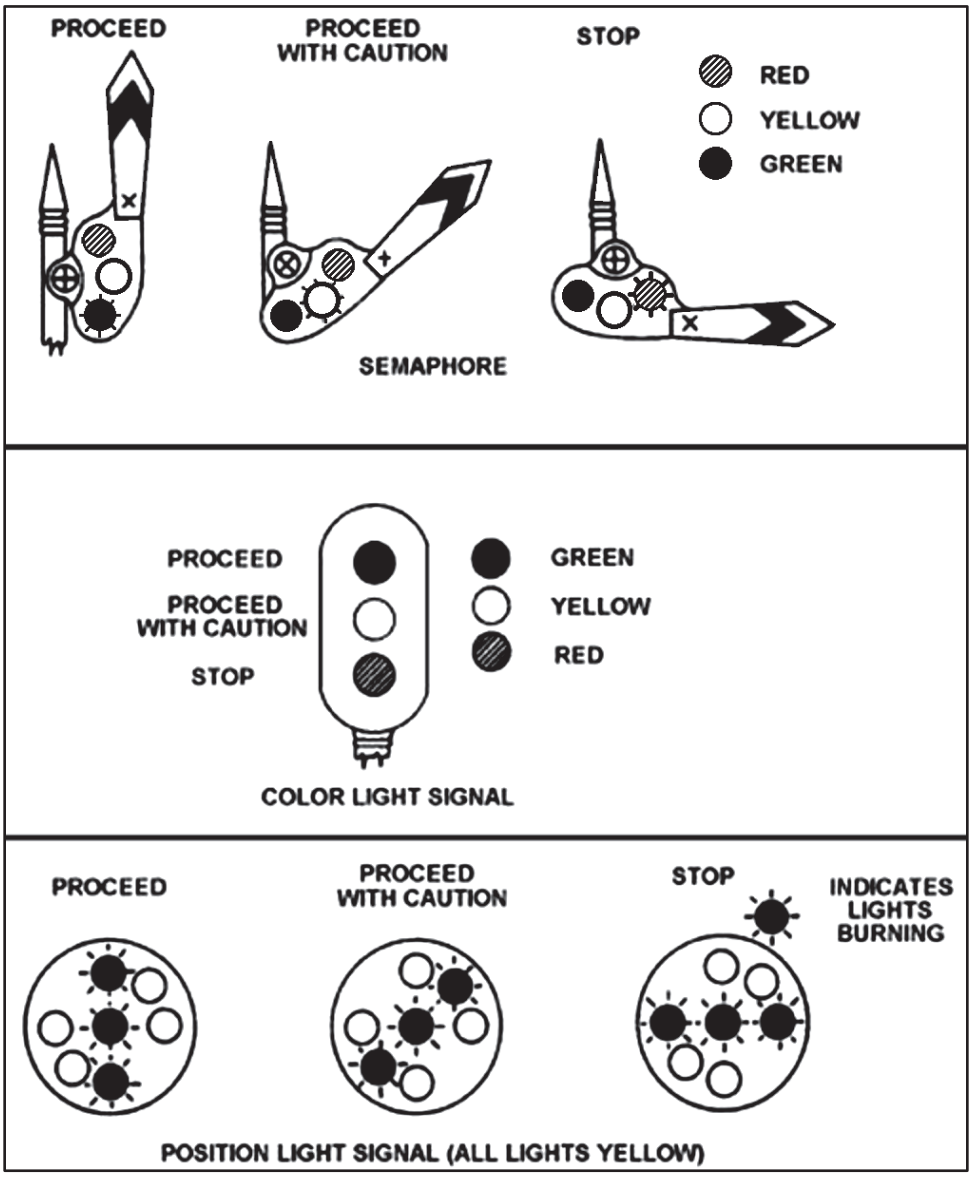


Figure E-1. Fixed signals

Semaphore

E-30. The semaphore consists of an arm or blade secured by a moveable mechanism to a vertical pole or mast. When the arm is in a vertical position (straight up) the train may proceed. When it is in a horizontal position (straight out from the post) the train must stop. If the signal is in approximately a 45-degree angle (between straight and straight out) the train may proceed with caution at a reduced speed. If the signal is in any position other than the three named positions, the train must stop. A signal imperfectly displayed or the absence of a signal must be promptly reported to the train dispatcher. This measure protects against defective signals endangering the movement of trains. During nighttime operations, the semaphore also has lights that can be seen as the arm is raised or lowered.

Color Light

E-31. The color light signal has three lights: red, yellow, and green. It is similar to traffic-control lights at street intersections.

- The train must stop if the light is red.
- The train may proceed if the light is green.
- The train may proceed with caution, but at a reduced speed, if the light is yellow.
- As a safety precaution, the train must stop if two or more lights are burning at the same time or if all the lights are out.

Position Light

E-32. The position light signal is used extensively worldwide. Therefore, it is likely to be present in a theater of operations. This signal has yellow lights arranged in a circular pattern around a central light that burns in rows representing semaphore arm aspects. A vertical row of lights means proceed; the next two blocks are clear. A diagonal row means proceed with caution at reduced speed; the next block is clear, but the one beyond it is occupied. A horizontal row means stop; the next block is occupied. The position of the lights rather than their color denotes the command signal. Any combination of light positions other than those stated means to stop.

SIGNALING PROCEDURES

E-33. As a train leaves a yard, the engineman should begin calling and repeating signals. The engineman calls each signal indication along the main line by name. The head brakeman (or the fireman if steam active power is used) will answer the engineman as they read the signal. All signal interpretations must agree between the engineman and head brakeman. Calling and repeating signals is essentially a safety measure.

E-34. Main-line tracks equipped with automatic block signals are divided into sections which have signals to show whether the two or more block sections immediately ahead are clear or occupied. Try to space signals at uniform distances. However; curves, sighting distances, bridges, tunnels, traffic congestion, and speed limits frequently prevent this from happening.

E-35. The signal name, when it is first seen, is called and repeated. The engineman must watch the signal for possible changes until the train has passed the signal. Aspect 1 may change to a more restrictive aspect if a switch is opened in one of the two blocks immediately ahead. Aspect 2 cannot change to a more restrictive aspect unless a switch is opened between it and the next signal, but it may return to clear (aspect 1). Aspect 3 cannot change to aspect 1 without first changing to aspect 2, unless the train causing the indication has left the main track for a siding. The stop indication must be observed and the train must not pass.

E-36. For dispatching, the ideal arrangement for train movement is to have trains spaced so that no train will be hampered in its progress by the stop or approach signals caused by the train ahead. However, this is not always possible, but it is a condition that train dispatchers should not forget.

E-37. Besides warnings, the engineman will use the locomotive whistle or horn for a variety of signals. Operating rules prescribe certain whistle signals that must be sounded in various circumstances. These whistle sounds include the following:

- Calling for signals from towers and stations.
- Whistling persons flagging a train in and out.
- Acknowledging signals from other trains.
- Calling attention to signals the train may be displaying for one or more sections.

E-38. The engineman must whistle for all public and private road grade crossings. The final whistle must be timed to occur when the engine is actually on the crossing.

CLASSIFICATION SIGNALS AND MARKERS

E-39. Even though markers are not signals, they do convey information about the train to operating personnel. Classification signals are placed on the front of the engine. These signals identify what type of train it is. The signals are flags during daylight hours and remain visible by the addition of lights at night. Flags and lights placed on the rear of the train are called markers. Every type of train must display markers to qualify as a train and to show the train is complete.

Classification Signals

E-40. A regular train displays no classification signals (figure E-2) in front unless it is being run in sections. The first (or leading) section of a regular train displays green flags by day and green lights by night on the front of the locomotive. Each section carries these same classification signals, except the last section, which carries none. For example, if a train is being run in three sections, the first two sections display the appropriate green classification signals and the last section runs as a regular train showing no classification signals in front. If there are only two sections, the first section displays the green classification signals; the second section does not. Extra trains are not run in sections. Extra trains always display white classification signals on the front of the locomotive. White flags are used during daylight; in addition, two white lights are used by night.

Markers on the Rear of Trains

E-41. Markers are displayed on the rear of all trains (see figure E-3). Because train operation in a theater usually takes place on single-track main lines, the discussion of train markers is confined to single-track operation. The markers displayed on a train on the main line are red and green flags used by day and red and green lights used at night. When red lights are displayed on the rear, it means that the main track is obstructed. A following train must approach at reduced speed. When a train is in the siding and clear of the main track with the switch lined for a through main line movement, it displays green flags by day and, in addition, green lights by night on the last car of the train. A single engine authorized by train order to run as an extra train must display white classification signals on the front of the engine and markers on the rear. An end of train telemetric device can serve as an end of train marker. This device also relays information to the locomotive operator and has replaced the need for a caboose on many railroads.

Color Indications

E-42. Color signal indications (table E-2) are standard for all U.S. railroads and many railroads seen around the world. Not only does the position of a signal give information to a railroader, but the color of the signal also has a specific meaning.

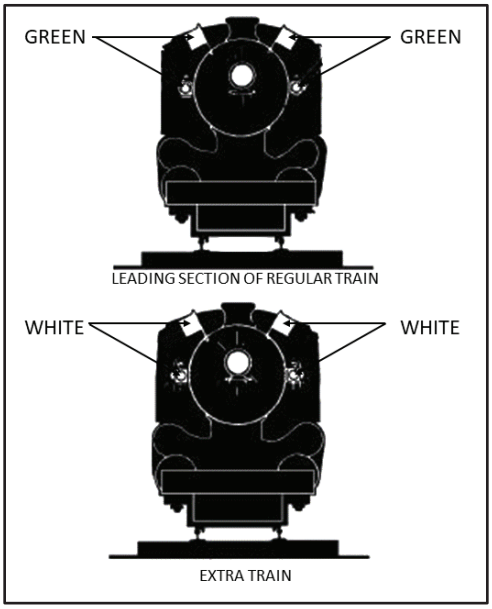


Figure E-2. Train classification signals

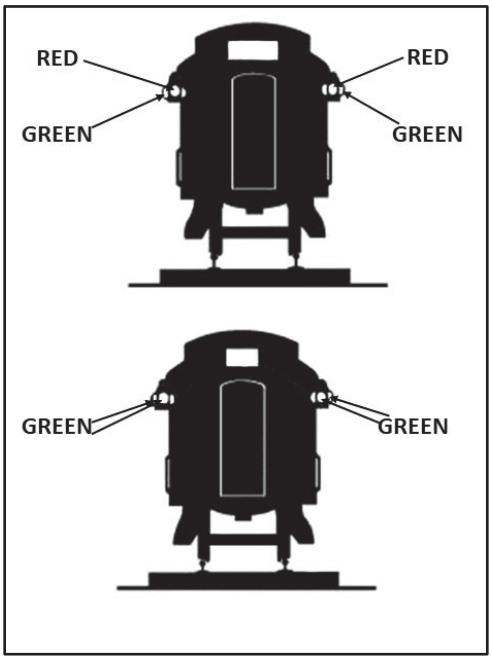


Figure E-3. Rear markers for trains

Table E-2. Standard color indications

Color	***Indication***
Red	Stop
Yellow	Proceed at restricted speed; Other uses prescribed by the rules
Green	Proceed; Other uses prescribed by the rules
Green and white	Flag stop
Blue	Protect workmen
Purple	Stop (indication for siding derailers)

E-43. These colors may be displayed in different ways or by different devices. A yellow disk denoting a zone of restricted speed may have the authorized speed printed on it in black numerals. A blue metal disk on a portable stand by day or a blue lantern or blue light by night, are used as a signal by maintenance personnel. It is displayed at one end or at both ends of an engine, car, or train to show that workmen are under or above it. No one except the person placing the sign in position can remove it. A green and white signal near the right-of-way on an approach to a station means the station is a flag stop. If no signal appears at the station, the train may continue without stopping.

NATO Train Identification

E-44. During operations in the NATO theater, identification symbols are assigned to trains to help standardize the procedures for moving forces within the territories of NATO nations of continental Europe. The procedures for obtaining these train identification numbers are found in the NATO Standardization Agreement 2468, *Technical Aspects of the Transport of Military Material*.

CLERICAL WORK AND CAR MOVEMENTS

E-45. Other duties the crew is responsible for include receiving messages, making reports, and setting off and picking up cars en route.

MESSAGES

E-46. When a train is moving, the head brakeman must be on the lookout for messages at all open towers. Messages are generally delivered "on the fly" by a message hoop, or loop, to which they are attached. The hoop is handed to the brakeman as they stand on the bottom locomotive step. The brakeman removes the message immediately and throws the loop to the ground as the train continues on its way. Messages may also be provided by radio if the locomotive is equipped.

DELAY AND ACCIDENT REPORTS

E-47. If the train is delayed en route, the conductor records figures for a delay report, showing every stop the train makes. The information includes the time stopped, time started, elapsed time, reason for the stop, and exact location. Should the delay involve an accident; the time and date, weather, names and addresses of the injured, witnesses, and damage estimates must also be noted. This information is sent in a separate report to the train dispatcher. When a stop is made and the conductor does not have enough time to get to the head end before the train starts up again, the head brakeman notifies the conductor of the reason for the stop before the delay report is filed.

SETOFFS AND PICKUPS

E-48. The head brakeman usually does the work involved in setting off and picking up cars en route. They get permission from the yardmaster or train dispatcher when making these car movements at yards and stations, and delivers and gathers waybills for cars the train leaves and picks up. When necessary to cross main tracks against the current of traffic, the head brakeman must assume head-end flagging duties. When the train leaves the area, switches and derailers must be relocked and left in their original or normal positions.

E-49. The conductor is responsible for the set out report. It is normally prepared in triplicate and routed through the chief train dispatcher to higher headquarters. The chief dispatcher will retain a copy.

NATO RAIL TRANSPORT REQUESTS

E-50. When operating in the NATO arena, request rail transport to move U.S. troops and equipment according to the *Procedures for Surface Movements across National Frontiers.*

SAFETY MEASURES

E-51. The safe movement of a train depends on the untiring watchfulness of the entire crew. The responsibility of watching for signs of trouble rests equally on each crew member. The engine crew is responsible for observing the track ahead and the conductor and flagman (rear brakeman) are responsible for protecting the train from collision at the rear. Crew members (at each end of the train) are also responsible for the following:

- Looking for hot journals.
- Shifting loads.
- Opening doors on boxcars and refrigerator cars.
- Dragging rigging.
- Other safety hazards.

E-52. These duties are best performed when the train is rounding curves and 30 to 50 percent of either end of the train is visible alternately from the engine. Other activities of the crew to keep a train safe and prevent accidents are discussed in the following paragraphs.

FLAGGING

E-53. From a safety standpoint, the flagman’s duties and responsibilities are equal to those of the engineman. Proper flagging and prompt compliance by enginemen are the only known means of preventing rear-end collisions on sections of railroad not protected by automatic train control.

SIGNAL LAMP MARKERS

E-54. An important duty of the flagman is to light, hang, and turn train markers. Markers are signal lamps displayed on the rear of a train. They have four opposing lenses: one is red and the others are yellow or green. The markers are placed on hangers and may be turned to show any of the colors or a combination of them. The flagman mounts the markers to show red to the rear when running on the main track with the current of traffic. When the train takes a siding, they reverse the markers to show yellow or green to the rear. If the flagman drops off the moving train to do flagging duties when entering a siding, the conductor must reverse the markers. The marker colors indicate to the engineman of a following train whether the train ahead is on the main or in a siding.

TRAIN OBSERVATION

E-55. The conductor and flagman spend much of their time looking over the train, the adjacent tracks, and the right-of-way. The observer is continually on the alert for smoke, the acrid odor of a hotbox (an overheated journal), or sticking brakes. A hotbox gives off brown smoke, while sticking brakes give off bluish smoke. If a hot journal is discovered, the train must be stopped and the car examined. It is often necessary to cool the journal, add fresh oil and packing, and set the car off at the next opportunity. Damage to the bearing and journal is not the chief danger resulting from a hotbox. If permitted to run unattended, it may become so hot that the axle could break, drop to the ties, and derail the train. The train dispatcher must be notified when a hot journal is set off en route, and the waybill must be endorsed showing the trouble and the disposition of the car. To keep the waybill and car together, the waybill must be left at the next office following the point where the car was set off. The head brakeman keeps watch from the head end. When trains are met or passed on adjoining tracks, the engine crew has little clearance to observe the other train. If one or two clear tracks separate the trains, the head-end crew scans the other train when passing. They watch for signs of hotboxes, dragging brake rigging, contents leaking from cars, shifted loads, and open doors on boxcars and refrigerator cars. They also watch for pilferers and trespassers.

HAND SIGNALS

E-56. Trains crews may substitute radio signals with hand signals. The four most common hand signals instruct the locomotive engineer to proceed forward, reverse, apply the brakes or release brakes. Additional train and crane hand signals can be found starting with figure G-1 on page G-5.

EMERGENCY STOP SIGNALS

E-57. When a train is passing a defective train, a signal must be given to the engine crew when passing the engine. If the defect is serious or if there is any doubt the signal is clearly understood, someone on the passing engine may throw off a lighted fuse in the path of the overtaken train. This will cause the train in question to stop and investigate the trouble before proceeding. The crew throwing off the fuse may throw off a written message at the next station advising the train dispatcher of their action and of the trouble with the train they passed.

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Appendix F

Yard and Terminal Operations and Procedures

Railway cars normally spend over half of their useful life in yards and terminals. The majority of operational rail personnel and equipment are involved in yard and terminal operations. Efficient yard and terminal operations are required if the railway is to exploit its maximum capabilities. In a HN, systems and procedures will most likely already be in place. This appendix offers ERC personnel methods utilized by Army rail units of the past, some of which may be obsolete for an American railway, in the event that HN methods are found to be in need of revision.

RAIL YARDS

F-1. As discussed in chapter 3, a rail yard is a system of tracks within defined limits used for making up and breaking up trains, and storing cars. Railroad yards are natural bottlenecks in any railroad, which makes the efficient operation of the yards extremely important. A railcar can only process through a yard as fast as the yard personnel can effectively move through their own procedures.

PROGRESSIVE YARD

F-2. A progressive yard is a multifunctional yard, mainly located at a busy terminal, structured to move cars in a fluid and rapid manner through its subdivided yards including receiving, classification, and departure yards.

Receiving Yard

F-3. A receiving yard (or receiving tracks) is where trains are cleared promptly on arrival to prevent main line congestion. As a train approaches the terminal area, it enters the yard by a lead track and clears the main line so that other traffic is not tied up. The road locomotive is uncoupled and goes to the enginehouse for inspection and repair (if necessary). At this point, the train loses its identity and becomes a draft of cars. A yard clerk collects the freight waybills and makes a track check from which a switch list is prepared. On the track check, the yard clerk records the initials, numbers, seal numbers, and kinds of cars in the order they stand (from front to rear) and shows whether the cars are loaded or empty.

F-4. After removing the locomotive, car inspectors place a blue safety flag or marker at each end of the draft of cars and make a thorough inspection of each car. Inspections include complete checks of the following:

- Brake system and rigging.
- Journal boxes (including journals, packing, and lubrication).
- Wheels and axles.
- Couplers, draft gear, and underframe.
- General state of the car body and its load.

F-5. Car inspectors should start at both ends of the draft of cars and walk along each side while making the inspection. In some yards, a pit may be dug beneath the tracks. While in the pit, an inspector can observe the underside of a car and its wheels and axles. When a defective car is found that cannot be immediately repaired in the receiving yard, a bad-order car is prepared with defects noted and attached to the car. The car is then placed on a bad-order track to await movement to the repair tracks. When the inspectors complete their work, the blue safety flag or marker is removed and the draft of cars is ready for switching to the classification yard.

Classification Yard

F-6. The classification yard is the yard next to the receiving yard where cars are sorted or classified according to destination and priority of movement. In classifying by destination, the yardmaster designates by number, the tracks in the classification yard to be used for the cars for each destination. If there are a large number of cars for a particular station, tracks may be designated by station. For example, cars are blocked consecutively in the draft so the first cars to be set out en route are directly behind the locomotive. This prevents delay when the blocks of cars are set out along the line. Individual cars or groups of cars are switched to the various tracks according to a switching list that specifies the track number for each car.

F-7. When an artificial hill is built in the classification yard, the entire yard is called a hump yard. In hump switching, a switch engine pushes a draft of cars from the receiving yard up the hill or hump. At the crest of the hump, they are individually cut off and permitted to roll by gravity down the hump to the designated classification track. The conductor or brakeman positioned on the hump cuts off the cars in switch-list sequence as they go over the crest. Control of the car speed is either by handbrakes operated by brakemen riding the cars or by retarders controlled by a tower operator. The advantage of hump switching is the quick and efficient way in which cars can be switched and classified with a minimum use of motive power. Hump switching is much faster than flat-yard switching because the movement is in a forward direction only and does not involve the back-and-forth movements of the locomotives. An entire train can be switched at one time, the train length being limited only by the pushing power of the switching locomotive. However, hump yards are expensive to build and are usually used only in large progressive yards where there is enough traffic to justify their expense.

Departure Yard

F-8. Once cars are classified, they are switched to the departure yard, the yard where classified cars are made up into trains. The cars are grouped from front to rear in the order in which they will be set off en route or in the order that will make switching easier at the next terminal. After a train is assembled, the train consist (a list of cars that make up a train) is prepared and sent to the yard office. Car inspectors make the departure or terminal airbrake test and another general inspection. While they are checking the cars, the road engine crew switches the engine from the engine ready track to the front end of the draft of cars. The train conductor must get the waybills and the train consists from the yard office and train orders and Clearance Form "A" from the train order office. Train orders give the priority of movement on the main line and the Clearance Form "A" (see appendix A) gives the exact time the train is authorized to occupy the main line. When the brake tests are completed and the inspectors are satisfied the equipment is in good shape and ready to operate, markers are placed on the rear of the last car and the draft of cars officially becomes a train. The train may leave the yard when the chief train dispatcher gives the signal.

COMBINATION YARD

F-9. A combination yard is a yard that incorporates the receiving, classifying, and departure facilities into one yard due to an insufficient volume of work to justify three separate yards, or from a lack of land to expand the yard layout. In combination yards (figure F-1), the number of tracks may depend on the volume of traffic. The established length of inbound and outbound trains determines the track length. These yards are generally flat. Switching is accomplished by the back-and-forth movement of a yard engine with cuts of cars. Since this method prevails in most small yards, flat-yard switching is generally done in combination yards. In a combination yard, it is impossible to arbitrarily assign specific tracks for receiving only. Road trains must be taken into the yard without delay to prevent blocking the main track. The yardmaster decides which track to use. However, in a crowded yard, the yardmaster may be forced to accept a train on any track that is able to accommodate it. It may be necessary to use two tracks if the clear tracks are too short to accommodate the entire train. The longer tracks are used interchangeably for inbound and outbound trains and the remaining tracks are used for classification.

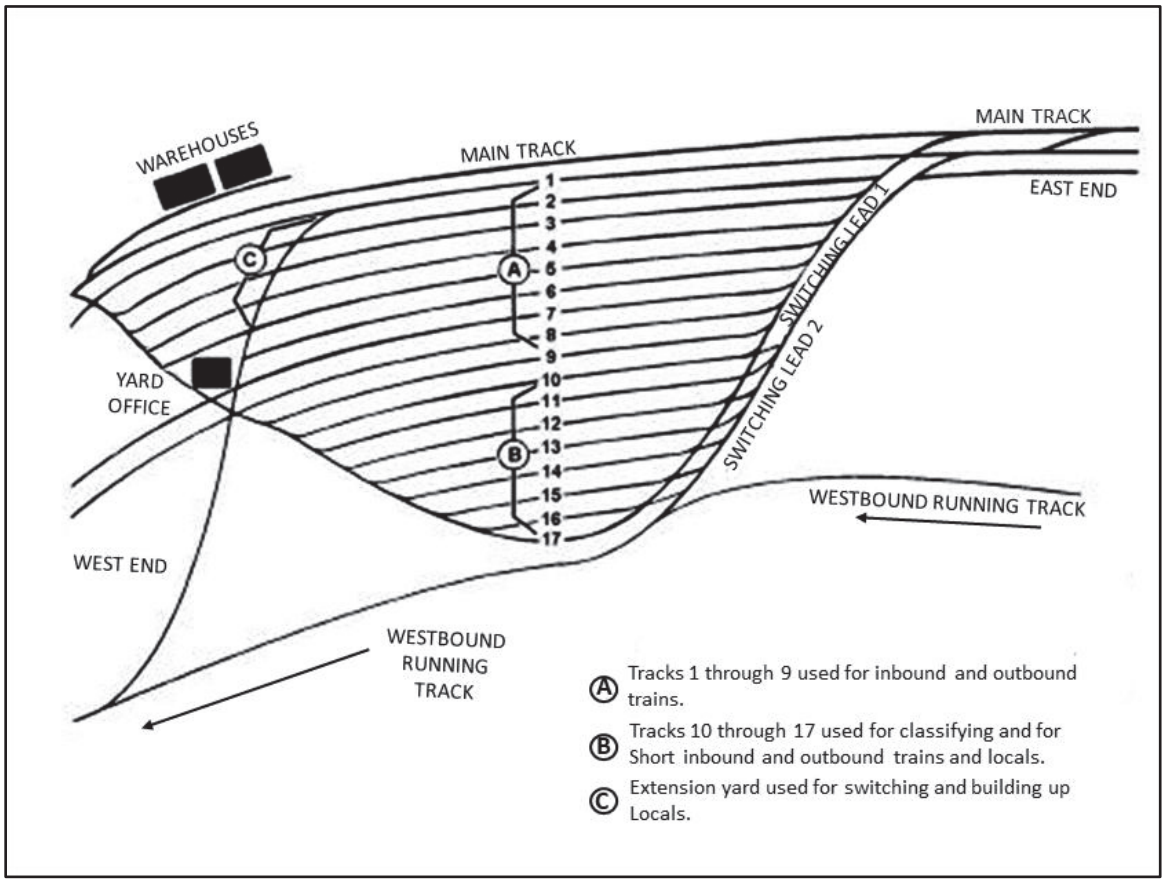


Figure F-1. Typical combination yard

TERMINAL FACILITIES

F-10. A railway terminal is a large installation at the beginning and end of a rail line for delivering and receiving freight or loading and unloading passengers. In a theater of operations, a military rail line will generally have a terminal at the beginning of the line, but usually the forward end of the line will end at a railhead. Adequate terminal facilities are of vital importance in railway operations. Congestion can occur if facilities are not properly used or if they do not exist. The following can result if congestion occurs:

- Cars cannot be moved.
- Cars cannot be promptly loaded and/or unloaded.
- Tactical forces may be deprived of urgently needed supplies.

SERVICE FACILITIES

F-11. Every railway terminal includes one or more of the types of yards discussed above, plus other installations which may include inspection and repair tracks, locomotive ready tracks, fuel, sand, and water service facilities, ash pits, scale tracks, and so forth. Buildings within the terminal include the following:

- Sand houses and supplies which are located near service tracks.
- Shop buildings at the repair tracks.
- Yard offices and towers near the center of the yard for the control of classification and switching operations.
- Other buildings that provide billet and mess facilities for train crews.

FREIGHT STATIONS

F-12. Freight stations are named buildings, sheds, or warehouses. These stations provide facilities for the receipt, loading, unloading, or storage of equipment and supplies. Loading and unloading areas preferably have separate routes for vehicles to enter and depart. End ramps are provided for wheeled and tracked vehicles. The named freight station and consignees should be clearly shown on waybills or other documentation to permit prompt placement of cars by yard operating personnel.

PASSENGER STATIONS

F-13. Facilities for moving personnel by rail should include one or more tracks on which cars can be placed before boarding time. Where facilities allow, cars used for the movement of troops should be cleaned, inspected, and watered before being placed for loading. When cars are equipped for steam heat, they should be heated (during cold weather) before troops board by using a station line, heater cars, or locomotive. Space, free of vehicular traffic, should be available adjacent to the loading track. This will allow personnel to assemble according to plan and permit ready handling of baggage and equipment. Station facilities should include office space for field transportation officers and ERC operating personnel, waiting rooms, storage sheds, car cleaning and watering tracks, and so forth.

ENGINEHOUSES

F-14. The enginehouse contains repair equipment, materials, and tools used to inspect, service, and make running repairs on locomotives that operate on the railway division. Enginehouses (or roundhouses) are quite vulnerable to air attack because they, with the usually adjacent turntable, are easily identified from the air. Where enginehouses are not available or are not usable for tactical reasons, tracks adjacent to the yard should be set aside for servicing locomotives. Such facilities should include fuel and water supplies, a pit for inspection and minor underneath repairs, ash pits for cleaning fires if steam locomotives are used, and a Wye track for turning locomotives in the absence of a turntable. Any new enginehouse constructed should be a simple, rectangular, functional, shed-like structure. If necessary, store needed equipment and tools in boxcars. A mobile workshop, operating from a mobile machine shop car, may be used at outlying points where no facilities exist and new construction is not feasible or justified.

TRACKS AND YARD CHARACTERISTICS

F-15. To expedite yard work, certain tracks are necessary. These include main tracks outside the yard tracks, divided leads, running tracks, switching leads, sufficient track length, and so forth.

OUTSIDE MAIN TRACKS

F-16. When main tracks are outside the yard tracks, time may be saved in switching cars. When a main track separates a main yard from an auxiliary yard, crews are delayed in crossing from one yard to another. Yardmasters have no control over the main tracks, and crews must obtain the train dispatcher's permission before crossing the tracks. For example, a yard crew of 30 or 40 cars crossing the main track will interrupt the entire switching operation for 15 to 30 minutes depending on main line traffic. An ideal arrangement is to have the main tracks located several kilometers from yards or yard tracks. A main track with a low TD may not restrict yard work significantly. One with a high density of traffic may deal with yard operations to the extent that it might be advantageous to relocate the main track.

DIVIDED LEADS

F-17. Divided leads may be located at each end of a yard. This enables two yard crews to work at the same time. Where only a single lead exists and two crews are employed, one crew must generally couple cars and make room on tracks while the other uses the lead in switching cars.

RUNNING TRACKS

F-18. ***Running tracks*** **are tracks that extend the entire length of the yard and provide a route of travel to any point in the yard independent of the switching leads and classification tracks.** When two running

tracks exist, they are assigned directional designations. Most railroads permit road and yard crews to use these tracks without prior permission from the yardmaster. However, their movement must be in the direction specified by the track designator. With the exception of yard facility tracks, running tracks are generally the only ones that may be used without permission.

LONG LEADS AND APPROACHES

F-19. Switching leads provides access to any point within a yard. They must be long enough to handle the longest length of cars normally handled. They must also lead out of the yard to running tracks or to the main line. Long approaches to the switching leads are desirable so that yard crews can move long cuts of cars from one track to another.

TRACK LENGTH

F-20. Tracks should be long enough to handle inbound and outbound trains without doubling or moving cars off one track and coupling to cars on another. For example, if a 100-car train enters a yard on a track that can hold only 65 cars, the train must double 35 cars to another track and block the lead while making the double. When an outbound train is built up on two or more tracks of limited length, delay will occur in doubling the train. When the train is on one track, the air test, which must be made only after the train is complete, can be made before the train moves out to block the lead. Pusher engines may be used to help reduce the delay by pushing the train out of the yard.

OTHER TRACKAGE

F-21. Specialty tracks are discussed below.

Ready Tracks

F-22. Ready tracks are located near enginehouses and are used when moving locomotives waiting to go on the road. When a locomotive is ready for road or switching service, it is moved to the ready track. When the locomotive is needed, it is moved through the lead track to the front of the assembled train. Facilities to inspect, water, fuel, and sand locomotives are located alongside the ready track.

Repair Tracks

F-23. Repair tracks (or rip tracks) are located in the receiving yard. They are used during inspection to repair cars with mechanical defects. Light and heavy repairs are made to cars in a large rail yard and therefore require both light and heavy repair tracks. If the volume of traffic is great, rebuilt facilities may be required. In any small yard, there will always be light repair tracks. Mechanically defective cars are switched from trains and placed on bad-order tracks leading to the repair tracks. If extensive repairs are required on a loaded car, transfer tracks are used to transfer the freight from the defective car to another car to prevent long delays. If perishables are being handled, facilities for re-icing cars or servicing mechanical refrigerator cars are required.

Inspection Tracks

F-24. Inspection tracks are used to inspect locomotives and cars. The tracks may be equipped with a pit and floodlight so the inspector can examine the underframe of cars, trucks, and locomotive running gear.

Team Tracks

F-25. Team tracks or spurs provide a place for loading and unloading railcars and must be accessible to motor vehicles. They are frequently near ramps to allow for easier loading and unloading of vehicles on flatcars for piggyback movement. Shippers provide their own vehicles for loading and unloading cars on team tracks.

Dangerous Commodity Tracks

F-26. Dangerous commodity tracks are provided for handling ammunition, explosives, and petroleum, oil, and lubricant products. These tracks are isolated from other tracks in the yard. Other tracks may be identified for the thorough decontamination of locomotives and railcars.

Miscellaneous and Special Tracks

F-27. Miscellaneous tracks include special tracks such as wreck train and work train equipment tracks and storage tracks for cars loaded with sand, gravel, rails, crossties, and other maintenance of way materials. They are functionally located within the yard and are readily accessible when cars are switched out and placed in trains. If a railroad handles livestock and perishable freight, it must have facilities for feeding, watering, and resting livestock, and for re-icing refrigerator cars containing perishable shipments.

YARD PERSONNEL DUTIES AND RESPONSIBILITIES

F-28. The operation of a yard at a rail terminal requires a large number of workers assigned to a variety of duties. The following describes the duties of the yardmaster, yard clerks, yard switching crews, and car inspectors.

YARDMASTER

F-29. The yard office is the workshop from which the yardmaster supervises and coordinates all yard and clerical work. The yardmaster is in complete charge of all workers and all activities within the yard. They are responsible for safely, speedily, and economically switching inbound trains and building up and forwarding outbound trains. These duties include distributing cars in the yard, assigning tracks for loading and unloading cars, assigning work to switching crews, and calling train crews. The clerical work in yard operation is also the yardmaster's responsibility. This work consists of the following:

- Making track checks.
- Notifying local consignees of cars arriving for them.
- Maintaining car record books.
- Compiling train consists.
- Sorting and distributing waybills.
- Preparing any other documentation necessary for dispatching trains from the yard to their destination.

F-30. When planning the switching of trains, the yardmaster must consider freight on hand. When a yardmaster reports for duty, they should check the lineup of incoming trains and the cars already in the yard. They should immediately begin to plan the makeup of trains to clear the yard for inbound trains. The check is made using the yardmaster's journal.

F-31. The yardmaster's journal, sometimes called a turn-over book, provides information needed in planning the switching and make up of trains. It is an up-to-date, permanent record maintained by each yardmaster on each shift. It is used to inform each yardmaster of the status of every track in the yard.

F-32. The actual format may vary among railroads, but information found in journals are basically the same. In a theater of operations, journals are kept as simple as possible and show only essential information. In addition to the name of the yardmaster, the terminal or yard name, the date, and the time, the journal may also show the following:

- A consist or lineup of inbound trains due in the next several hours. If there is no figure for the estimated time of arrival, the train dispatcher will estimate the arrival time later.
- The listing of every track in the yard including cars and their contents.
- The status of every track in the yard to include whether the cars are coupled, whether they are at the east or west end, or whether the cars on the shop tracks are spaced or not.
- An appropriate notation is also made if the air has been tested and approved on any track.

- A list of the yard crews and locomotives that will be working during the oncoming shift, exactly what each crew is doing at the time of the yardmaster's change, and where each engine is awaiting relief. Yardmasters usually change shifts a half or full hour before yard crews change.
- A list and consist of trains ready for departure.
- Any other data pertinent to yard operations. The journal pages have wide margins to allow for additional entries as work progresses. After 2300 hours, all cars switched to the tracks from the west end of the yard will be entered on the right side.

YARD CLERKS

F-33. Yard clerks prepare train consists, switch lists, and do other administrative jobs assigned by the yardmaster. They also make yard checks, maintain an exact, up-to-the-minute location of all cars, and check car numbers of all arriving and departing trains. The number of yard clerks required depends on the type and volume of work to be done. Three clerks are usually required on each shift. One clerk handles the inbound clerical work, one does all outbound clerical tasks, and the third is assigned to checking cars. When there are a large number of tracks, two or more clerks may be required to check cars. Clerical duties may vary considerably among railroads in different localities.

Inbound Clerical Work

F-34. During inbound clerical work, the initials and numbers of all cars arriving in the yard must be entered in the car record book. The inbound clerk checks the waybills against the completed track check and makes sure that the numbers on the track check agree with those on the waybills. They must also make sure that there is a car for every waybill and vice versa.

F-35. Many other reports are often necessary. These include arrival notices to local consignees, hold notices, reweigh reports (necessary when bulk-loaded cars have lost part of their lading), and seal reports. All yards stamp each waybill on the back with a junction stamp showing the time and date of arrival and the name of the yard. Clerks are then able to check the time interval of cars in and between various yards. These notations also enable yardmasters to inquire or start corrective actions concerning cars that are subjected to unreasonable layovers between point of origin and destination. Most yards maintain an inbound and outbound train sheet that shows the engine number, conductor’s name, arrival or departure time, and the number of loads and empties in each train. The train sheet is usually maintained from 0001 through 2350 hours.

Outbound Clerical Work

F-36. When an outbound train has been called, the clerk assigned the outbound duties computes the gross tonnage. The following forms help the outbound clerk to keep an accurate account of all trains and freight leaving the yard.

Train Consist

F-37. A train consist is prepared by showing a list of the cars which make up a train. The report shows the initials, number, if it’s loaded or empty, weight, and destination of each car in the order (from front to rear) in which the car stands in the train. Immediately after a train is dispatched, the train consist is sent by telephone or teletype to the yard at the train’s destination. No standardized format is prescribed for the train consist. Four copies of the train consist are required for distribution. Distribute the consist as follows:

- Original is sent to the car records office for posting and filing.
- A copy goes to the transportation movements officer at point of origin.
- A copy is kept by the yardmaster at train origin.
- A copy goes to the yardmaster at train destination.

F-38. The yardmaster uses it to plan the switching operations and track allocations. The train consist is also placed in permanent files for use in financial accounting.

Commercial Freight Waybill

F-39. A commercial freight waybill authorizes a common commercial carrier to move a railway car. The shipper prepares a waybill. There is no universal standards for a commercial freight waybill but it generally shows the following:

- Car number and initials.
- Contents.
- Weight.
- Consignor.
- Consignee.
- Origin.
- Destination.
- Date of issue.
- Number of seals used (if any).
- Routing.
- Any special instructions.

This information is used to trace the shipment if it is lost, stolen, or damaged while en route.

Note. A home route card may be used and attached inside the waybill when the railcar is to be returned to the origin point. This would normally be used for special type cars to handle specialized cargo.

Transportation Control and Movement Document

F-40. Transportation control and movement documents may be used for shipments from military activities and may also be used as a freight waybill. These documents should include the information found on a commercial freight waybill as well as the number of any seals used, routing, and any special instructions.

Track Check

F-41. The outside clerk ensures that information on the track check corresponds to the waybill and the train is in station order. The clerk formats the track check and must show the initials, number, and type of each car (box, tank, hopper, or flat). The clerk indicates, at the top of each sheet, which end of the train the check was started.

Switch List

F-42. The switch list can be prepared using the same format used for the track check (except a column for destination and track are added). The clerk prepares the switch list using information on the track check. In turn, the switch list shows the destination of each car, whether it is empty or loaded, the track to which a car must be switched, and the number and size of the cuts to be made in breaking up the train.

YARD SWITCHING CREW

F-43. A yard switching crew is generally composed of three members: the engineer, the conductor, and a brakeman. The brakemen may also be called a switchmen. The brakeman working farthest rearward from the engine is known as the rear brakeman. If workload requires, additional brakemen may be assigned. Where a long lead with a large number of switches exists, an extra brakeman or a switchtender may also be assigned. The yard conductor, sometimes called the switch foreman, is in complete charge of the crew and is responsible for carrying out the yardmaster's instructions in a safe and expeditious manner. The yardmaster usually delivers instructions in writing if verbal instructions are complicated or would be confusing. The conductor must fully inform their crew what to do and how to do it. The yard conductor normally uses a switch list. The switch list will be developed from information obtained from the track check.

ENGINE CREW

F-44. The engine crew consists of an engineer. The engineer works under the direction of the yard conductor. The engineer and conductor are both responsible for safe and efficient operation of the locomotive. The engine crew is also responsible for certain duties in switching operations. These duties include the following:

- Executing signals given by the ground crew.
- Interpreting hand signals and refusing any signals not clearly understood.
- Calling and repeating hand signals, switch-light colors, and signal-light aspects to each other to ensure signals are read properly.
- Answering the whistle signals of main-track trains with the appropriate whistle signals of the yard engine.
- Complying with timetable instructions in crossing main tracks.
- Questioning a signal when it may be unsafe to obey.
- Periodically inspecting and lubricating the locomotive's running gear.

INSPECTORS

F-45. Inspectors examine and make running repairs to cars entering a yard. Air inspectors test the air brake equipment of trains after they are built up and before their departure from the yard. All inspectors must be cautious when inspecting inbound cars. Chemical contamination may be present and unknown to the train crew. Suspicious liquid concentrations should be tested and all contaminated rolling stock marked using standard NATO CBRN markers.

Car Inspectors

F-46. One of the most important jobs in the movement of trains is that of the car inspectors. Car inspectors must check each car for over 200 possible defects. Inspectors are required to make close inspection of wheels and flanges, journals and bearings, underframes, brake rigging, handbrakes, air brake equipment, grab irons, sill steps, draft gear, and many other parts. If defects are not noticed and corrected, serious consequences may result. A defective car in a train could cause a derailment or a lengthy delay in setting the car off en route. Roof sheets, ladders, and running boards on closed-top cars must also be inspected. Experienced personnel can inspect a car in a short amount of time.

Air Inspectors

F-47. Inspectors, although qualified in all phases of inspection, are frequently detailed to air inspecting and testing only. When a train is coupled, it is moved to a point where the air hose on the first car is over the hose connected to the ground air line. Air inspectors couple air gauges between these hoses and walk the length of the train, coupling the hoses between cars as they progress. When all hoses are coupled and enough pressure is attained in the train line and reservoirs, brakes are applied on the train. Inspectors examine the piston travel to determine if enough braking force is being exerted on the wheels of each car. Linkage may need to be adjusted so that brake shoes will exert proper force. Every car is inspected for excessive air leakage and gauges are checked to determine the entire train line leakage. If leakage is within permissible limits, the train is reported to the yardmaster as ready for movement. The car inspectors will write a "shop" or bad-order tag for those defective cars that cannot be immediately repaired. These cars are cut out by the train yardmaster.

FREIGHT GROUPING AND CLASSIFICATION

F-48. The governing principle throughout the grouping or blocking process is to group each cut of cars by destination so that its position in the outbound train requires a minimum of handling in setting it off. Classifying cars involves assigning them to a particular destination grouping and switching them to a track having the same grouping. When enough cars accumulate on the same track, either of one group or a combination of groups, an outbound train is ordered. Cars consisting of several groupings or blocks are set into the train in the order they will be set off along the route. The first block to be set off is placed immediately behind the engine, followed by the next setoff grouping, and so on. Placing the blocks directly behind the

locomotive involves the least amount of movement in setting them off. In special cases, there may be exceptions to this sequence. For example, a group of expedite cars may be carried next to the engine (a location out of their normal standing). This position would enable the yardmaster at the receiving terminal to remove them from the train before car inspectors blue-flag the track on which they arrive. The cars would then be placed on the head end of a departing train (again out of their normal standing) and handled identically at the next division terminal. The cars would be kept on the head end of all trains until they arrived at their destination. This method could save as much as 48 hours over an 800-kilometer haul. It might be equally convenient to have a set off at either end of the train in a yard where the engine is to be changed.

F-49. A bill rack is another method of keeping track of waybills. However, it should never take precedence over the entries in the journal. The rack always contains a separate section for every track the yardmaster has jurisdiction over. Waybills are put in the sections in the exact order that cars enter and stand on the tracks. When a crew switches loaded cars in the yard, the yardmaster switches the waybills to the appropriate slots in the bill rack (see figure F-2). In a westbound yard, when cars are switched to the west end of a track, the bills are usually placed in front of those already in the particular track slot. When cars are switched to the east end, bills are placed behind those already in the rack. Do not assume that because a slot is empty, the track is clear—too many people use it. Careful switching of bills is as important as switching of the cars. When bills are correctly switched, one may see the exact standing of a track makes it a simple matter to estimate or compute the tonnage of any track when planning an outbound movement. The journal, never the bill rack, is the authority for determining the clear tracks. A particular slot in the bill rack may be empty but a mistake may have been made in switching the bills.

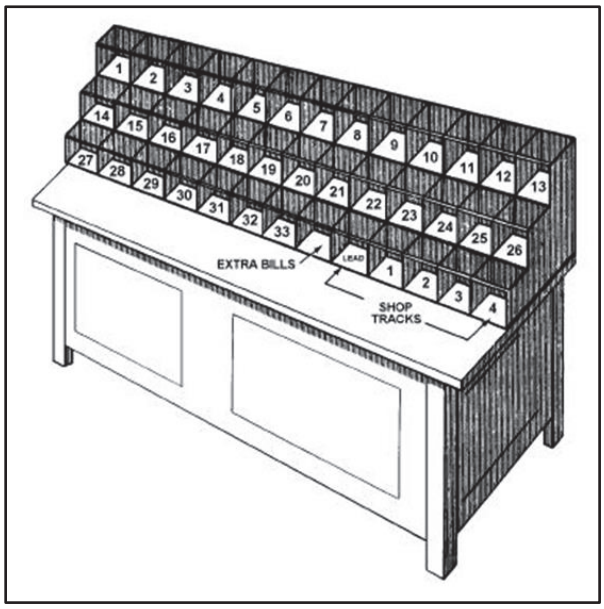


Figure F-2. Bill rack

Appendix G

Wreck Train and Equipment Operations and Procedures

Personnel engaged in the operation of wreck trains and wreck cranes are inherently involved with some of the most complex and dangerous operations on any railroad. This appendix discusses the highly specialized operations and procedures associated with wreck train operation. While the ERC does not perform wreck train or train lift operations, the following information is included for awareness and understanding.

INTERRUPTIONS TO RAIL TRAFFIC

G-1. Interruptions to rail traffic must be reported in a timely manner so that adjustments may be made in the traffic flow, the condition causing the interruption can be cleared as quickly as possible, and normal rail traffic can be resumed, which is the ultimate objective. Interruptions are classified as major interruptions and minor interruptions.

MAJOR INTERRUPTIONS

G-2. Interruptions may be listed according to their causes. Major interruptions in a theater of operations are caused by:

- Major derailments and wrecks.
- Natural causes (including floods, washouts, cave-ins, and slides).
- Enemy action.

Major Derailments and Wrecks

G-3. Clearing operations should be established from both sides of the derailment if wrecker equipment is available. To save time, pending arrival of the wreck train(s) or wreck crane(s) (discussed later in this appendix), undamaged cars should be pulled away from the site and parked on the first available siding or spur as soon as it is safe to do so after an incident. Damaged cars should be rolled off the right-of-way (if possible) and picked up later. Traffic should be rerouted if the length of the interruption justifies it and if an alternate line is available. A rail truck transfer point may be established if required. One method to deal with these kinds of interruptions that occur on a double-track line is to clear the line least affected, therefore restoring traffic quickly to the one track. The other line may be cleared later.

Natural Causes

G-4. Interruptions may also be from natural causes which include floods, washouts, cave-ins, and slides.

Floods

G-5. Flood waters cause serious damage to rail facilities, trackage, and equipment, including—

- Weakened or destroyed bridges, trestles, and culverts.
- Weakened or washed out grade ballast and sub-ballast.
- Water damage to equipment.
- Water damage to the contents of loaded cars.

G-6. Damaged track, roadbed, and structures may take several days or weeks to repair, which may cause operations to come to a standstill. Mud and silt left behind by receding waters interfere with the operation of

switches and any electrical-signal mechanisms. Keep in mind that rail lines which follow the course of a river to avoid steep grades, frequently incur serious damage when those same rivers flood.

Washouts

G-7. Flood waters may cause washouts that can carry away bridges, trestles, and culverts, and also railway equipment. Washouts may undermine sections of right-of-way and roadbed. Restoration may require temporary structures or field expedients. Action taken where washouts are likely to occur should be pre-planned and repair materials should be stockpiled at suitable locations. Reroute urgent traffic if alternate lines exist. Personnel may be transferred from one train to another by walking around the washout. Transfer points may be established if motor transportation and suitable roads are available.

Cave-ins and Slides

G-8. Tunnel cave-ins and dirt, rock, and even snow slides are of particular danger in mountainous areas. These may result from natural causes (such as earthquakes, melting snow, and soaking rains) or from enemy action (such as bombing, artillery fire, or sabotage). Cuts and slides are cleared in the most expeditious manner possible without regard to permanent construction. Heavy equipment should be requested from any available engineer service when clearing the obstruction is beyond the rail operating organization's capabilities. Where possible, a collapsed tunnel should be excavated to create a cut in its place. If this is not feasible, a bypass track may be constructed.

Protective Measures

G-9. When there is advance warning of extreme weather and expected flood conditions, critical freight and equipment branch lines beyond the threatened area, loaded cars, and other equipment should be moved to higher ground. Any storage or industry tracks that are higher than the yard or main tracks, and even those running up to and down from the hump yard (where one exists), should be filled with the loaded cars that are most vulnerable to water damage. Moving ammunition, explosives, clothing, and foodstuffs to higher ground should logically precede that of field pieces, vehicles, and other freight not particularly vulnerable to high-water damage.

G-10. Detailed standard operating procedures should cite the precedence of the freight to be moved to safety. If there are any branch lines that run at right angles to a threatening river, they may provide excellent storage places for vulnerable freight and equipment. If possible, all locomotives should be moved to higher ground. Diesel-electric and electric locomotives should be moved before steam locomotives. As previously stated, rail bridges over flooded rivers may be weakened or washed away. Bridges with many piers or timber-pile trestles are often most vulnerable because of pressure from collected debris. The weight of heavily loaded cars left on such structures usually tends to stabilize and assist in anchoring the bridge or trestle. Such cars should contain only low-grade aggregates such as coal, ore, sand, gravel, and so on. However, this method should not be used without approval from engineer bridge specialists or other qualified engineering personnel.

Terminal or Yard Congestion

G-11. Terminal congestion is often a by-product of a major traffic interruption, or of poor control of movements after a major interruption has been identified. To maintain fluidity, yards and terminals should not be filled beyond 60 per cent of static capacity. When a yardmaster can foresee that a yard is about to be blocked, they should report the situation to the chief train dispatcher. The yardmaster may request that cars be set off at sidings or diverted to other lines or yards until normal train movement is resumed.

MINOR INTERRUPTIONS

G-12. Although many factors cause minor interruptions, they are generally classified in one of the three common categories:

- Minor Derailments.
- Minor Floods, washouts, and slides.
- Signal communication interruptions.

Minor Derailments

G-13. Minor derailments are most often caused by either human error or equipment failures. Human error would include failures resulting from improper train operation, violation of safety and operational rules, or improper inspection or maintenance. Equipment failure, may include dragging brake rigging, sharp wheel flanges, splitting switches, wheels overriding derailers, and so forth. These minor derailments are usually repaired quickly by train crews using rerailing devices or jacks carried on locomotives. A more serious derailment may require that a wreck train be brought to rerail the car(s) and repair track damage. This sort of derailment would most likely be classified as a major derailment.

Minor Floods, Washouts, and Slides

G-14. Local track work gangs may have the capability to repair minor flooding, washouts, and slides. Rock, mud, or snow slides may be removed by local labor and maintenance of way equipment without the need of a work train. The necessary repair materials should be stockpiled at suitable locations along the right-of-way where these interruptions are frequent.

Signal Communication Interruptions

G-15. Local signal section personnel can usually quickly repair minor breaks in dispatcher circuits. As instructed by the chief train dispatcher, local block operations may continue the movement of trains by transitioning to fleet operations during such breaks. Signal service assistance may be requested in making signal and communication line repairs.

WRECK TRAIN OPERATIONS

G-16. ***Wreck train*** **is a train specially configured and tailored to conduct wreck recovery operations.** It usually consists of a locomotive, a wreck crane, tool cars, and enough bunk and cook cars for personnel required for a particular wreck. Wreck cranes and tool cars should be stationed at strategic points along the railway line. Wreck train equipment must remain prepared for immediate movement. Ties, rails, spikes, and other repair materials should be stockpiled at various points. An emergency supply of such items should also be loaded in suitable cars and held with each wrecker as part of the wreck train.

G-17. When a derailment, wreck, or any other traffic interruption discussed above, blocks main line traffic, the train dispatcher secures as complete a record as possible about the extent of the damage. They also estimate the time required in restoring train movement. The dispatcher orders and arranges for a wreck train and its crew to go immediately to the scene. In serious wrecks, the wreck train may be ordered out from points on both sides of the wreck to hasten clearing operations.

WRECK TRAIN CREWS

G-18. The mission of wreck train crews is to remove wrecks and other line obstructions. They also salvage or repair wrecked rolling stock so that it can be safely moved to the nearest ship or repair track. A wreck crew consists of the following:

- Wreck foreman.
- Crane operator.
- Car repairman.
- Welders (as required).

PREOPERATIONAL CHECKS

G-19. Experience has proven there are a number of potential hazards inherent to wreck train operations. Safety and maintenance preoperational checks to be performed before these operations are of extreme importance.

G-20. Engine fuel, lubricants, and water should be checked and brought to the proper levels. Open gears and fittings should be greased. Power stoppages and mechanical failures caused by inadequate servicing can cause damage and injury.

WRECK CRANES

G-21. Wreck cranes should have air brakes, hand brakes, and generators for electricity and lights. Cranes should be capable of self-propulsion in either direction. The following paragraphs discuss preoperational checks that must be performed on wreck cranes before operations.

DECKS AND PLATFORMS

G-22. Wreck crane decks and platforms must be kept free of grease, cables, chains, buckets, barrels, loose tools, and similar items. Machinery guards over open gears should be in place. Handholds and steps must be kept clean, secure, and marked as appropriate.

BRAKES, CLUTCHES, AND SWITCHES

G-23. The action and effect of all braking devices, clutches, and the engine cutoff switch should be checked and required adjustments made. On assuming their post, the crane operator will test the working condition of these controls and their ability to operate them quickly and automatically in an emergency. Crane operators must ensure that all dogs, pawls, and braking equipment are capable of effectively braking a weight of at least one and one quarter times the weight of the full rated load. Outriggers are used when testing a crane's rated capacity, but the rated capacity for the crane should be that given without outriggers.

CABLES

G-24. The crane should have an adequate quantity of the following to meet capacity lift requirements:

- Cables.
- Devices.
- Falls.
- Sheaves.
- Pulleys.
- Other miscellaneous hoisting equipment.

G-25. Blocks and cables should be clean, free of dirt and sand, and properly lubricated at all times. Cables and rope are kept free of kinks and are stored coiled. A crane operator, before beginning any lift operation, will inspect cables and wire ropes for broken wires, fractures, and flat or pinched spots. Sheaves and drums are checked for proper line placement.

WRECK CRANE OPERATORS

G-26. Statistically, a free moving crane is a potentially dangerous instrument. One-third of the injuries sustained in crane accidents result in fractures or severed limbs. Many of those injured are crane operators. Most crane accidents are preventable because they are, to a large measure, the result of actions, conditions, or situations directly under the control of the operating crews. Crane work must be the coordinated activity of a team of skilled workers. The operator, wreckmaster, riggers, and others assume control of lifts, movements, and similar actions. It is important that individual control responsibilities are clearly defined and the procedure for transferring them is thoroughly understood.

G-27. Crane operators must ensure that—

- Only authorized persons enter the crane cab.
- No one is in or about the crane before it is started.
- No hoist is made while anyone is riding on the load.
- A warning signal is sounded before traveling (moving the crane) or when the load approaches near or over other persons.

G-28. Additionally, a wreck crane operator must know the parts, principles of operation, and the safety precautions required of the crane to which they are assigned. They must be familiar with the types and capabilities of the cable rope, wire rope, blocks, hooks, and shackles with which their crane is equipped. An operator must be able to supervise the rigging of the crane for a particular lift. They must understand the

mechanical advantage of various pulley combinations, the use of dead-man rigs, and other expedients required in rerailing locomotives and cars.

WRECK TRAIN AND WRECK CRANE SAFETY

G-29. Personnel engaged in the operation of wreck trains and wreck cranes must be familiar with the current Army rail safety rules as directed by AR 56-3. All personnel whose duties are affected by the rules must be provided a copy. Wreck crane personnel must ensure cables and tackle of adequate strength are used when making heavy lifts. All personnel are also warned to stay away from any area where there is a possibility of being injured if a cable should break or a load slip.

SIGNALS

G-30. The wreckmaster, or someone designated by them, is responsible for giving signals. The responsibility for giving an emergency stop signal belongs to anyone on site who considers such a signal necessary. Copies of authorized signals should be posted in obvious places so wreck train personnel may become familiar with them. Crane and derrick operators must wait for a clear signal from the designated signalman before operating the equipment. If there is any doubt or confusion regarding the signal given, the operator must stop operations and clarify the signal before making another move. Figures G-1 below thru G-34 on page G-22 show standard hand signals that can be used when operating cranes and derricks, when visibility permits. Lights or lanterns can be used to give signals during periods of darkness. In the event that the HN uses different hand signals than what ERC personnel in an advise and assist role are used to, or there are differences between the signals used between different rail organizations, allied forces, or contractors, a standard set of signals must be learned and agreed upon by all parties involved in an operation.

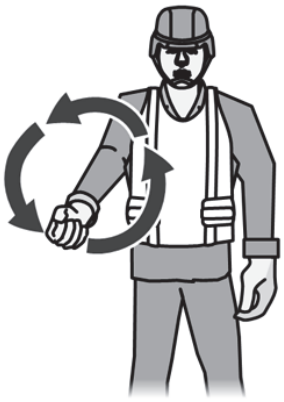


ATTENTION: Raise and extend the arm overhead. Move it to the right and left. *(Do not make a circular motion; that is a different signal.)*



ATTENTION (Night): Raise and extend the arm overhead with the wand pointed up. Move it to the right and left. *(Do not make a circular motion.)*

Figure G-1. Signal for attention

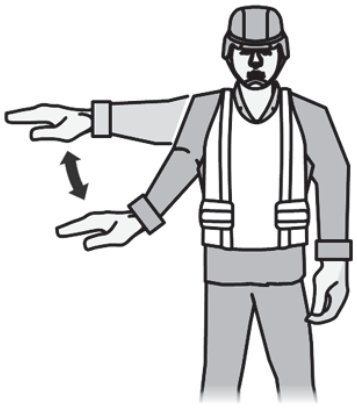


START ENGINES: Raise and extend either arm overhead. Point at the vehicle with the other hand and rotate the arm in circular motion.

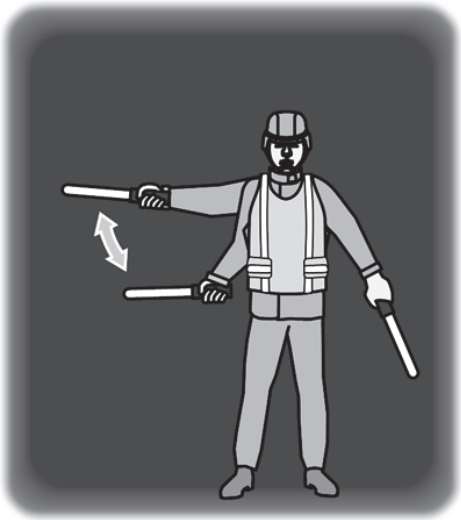


START ENGINES (Night): Raise and extend either arm overhead with the wand pointed up. Point at the vehicle with the other wand, and rotate the arm in circular motion.

Figure G-2. Signal for start engine

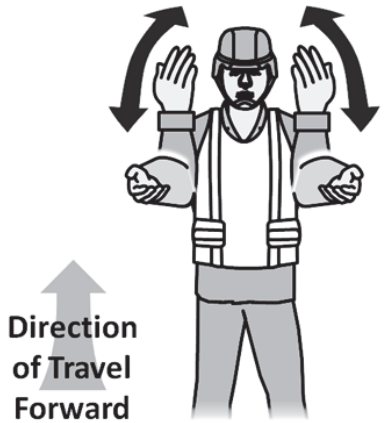


DECREASE SPEED, SLOW DOWN (Day): Extend the arm horizontally sideward, palm facing down, and wave arm downward several times, keeping the arm straight. (The arm is not moved above the horizontal plane.)

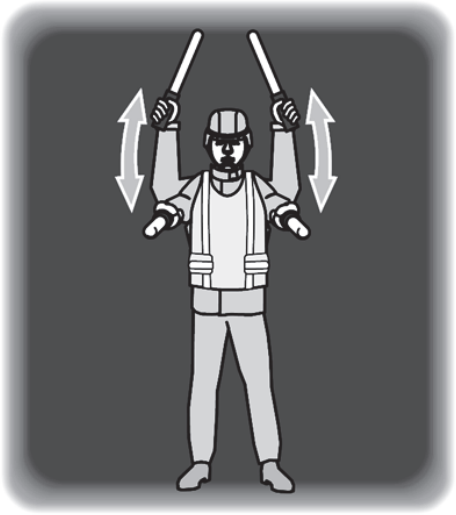


DECREASE SPEED, SLOW DOWN (Night): Face the vehicle, and hold the right wand out to the side, horizontal at shoulder level. Swing the wand to waist level, holding it horizontal. Repeat the swinging motion until the vehicle has slowed to the appropriate speed.

Figure G-3. Signal for decrease speed and slow down

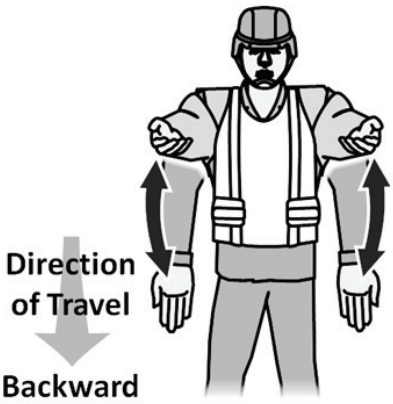


MOVE FORWARD (Day): With both hands, palm up, holding the arm horizontally to the front, point toward vehicle operator. Then beckon by repeatedly motioning upward, moving the hands to the side of the head.

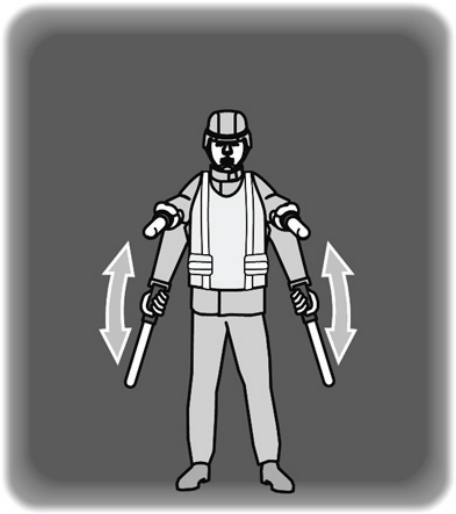


MOVE FORWARD (Night): Hold both wands in front of the body at shoulder level with tips pointed at the vehicle. Then beckon by repeatedly motioning upward, moving the wands to just above the side of the head.

Figure G-4. Signal for move forward



MOVE BACKWARD (Day): Raise the hands repeatedly form sides to chest level with the thumbs out and palms upward. (Sweep the hands in a slight forward and back pushing motion.)

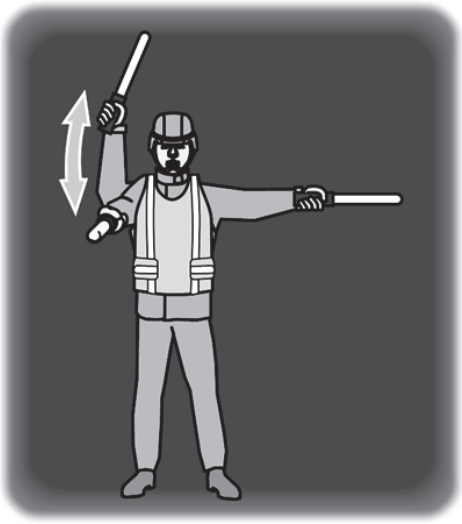


MOVE BACKWARD (Night): Raise the wands repeatedly form sides to chest level. (Sweep the wants in a slight forward and back pushing motion.)

Figure G-5. Signal for move backward



TURN RIGHT (Day): Extend the arm closest to the direction of travel horizontally, palm towards traffic to the indicated which way to turn. With the other hand, make the Come Forward signal.

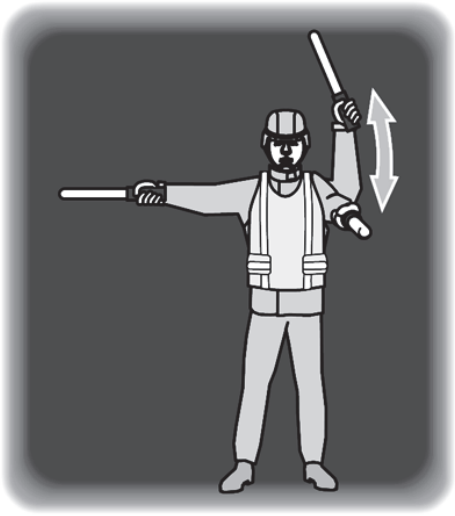


TURN RIGHT(Night): Extend the arm closest to the direction of travel horizontally, with the wand pointed to indicate which way to turn. With the other wand, make the Come Forward signal.

Figure G-6. Signal for turn right



TURN LEFT: Extend the arm closest to the direction of travel horizontally, palm towards traffic to the indicated which way to turn. With the other hand, make the Come Forward signal.

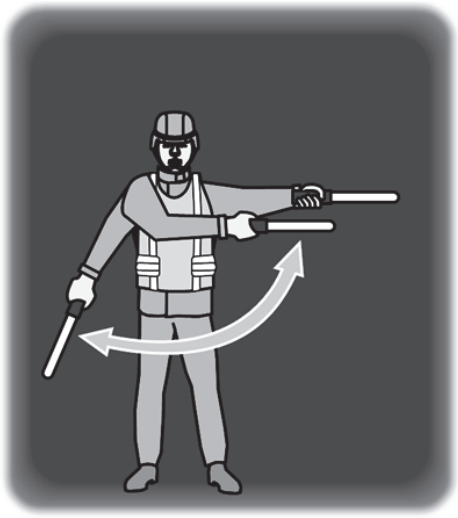


TURN LEFT(Night): Extend the arm closest to the direction of travel horizontally, with the wand pointed to indicate which way to turn. With the other wand, make the Come Forward signal.

Figure G-7. Signal for turn left

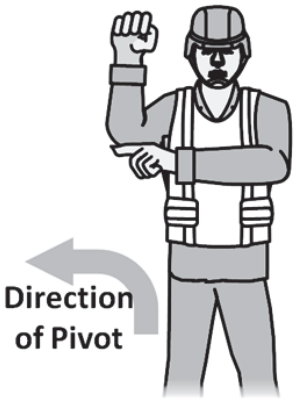


PIVOT RIGHT, Track Vehicles: Clench the left fist at head level, and point the index finger of the right hand in the direction of steer. *(Operator stops right track while the left track moves forward into the turn.)*

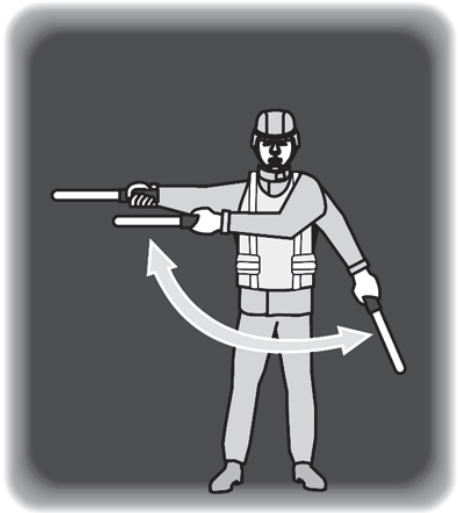


PIVOT RIGHT, Track Vehicles (Night): Extend the arm closest to the direction of travel horizontally, with the wand pointed to indicate which way to turn. With the other wand, make a repeated swing from the side of the leg to just under the extended wand.

Figure G-8. Signal for pivot right

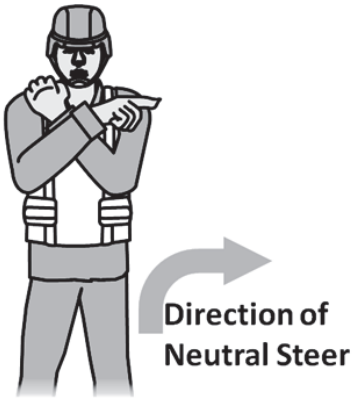


PIVOT LEFT, Track Vehicles: Clench the right fist at head level, and point the index finger of the left hand in the direction of steer. *(Operator stops left track while the right track moves forward into the turn.)*



PIVOT LEFT, Track Vehicles (Night): Extend the arm closest to the direction of travel horizontally, with the wand pointed to indicate which way to turn. With the other wand, make a repeated swing from the side of the leg to just under the extended wand.

Figure G-9. Signal for pivot left

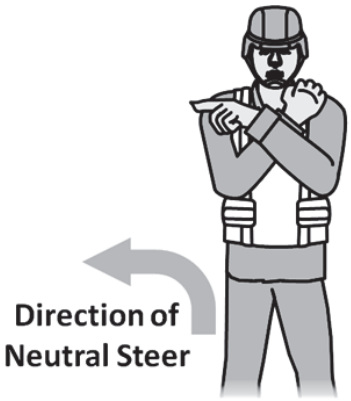


NEUTRAL STEER RIGHT, Track Vehicles: Cross the left wrists beside the neck with clenched fist. Point the index finger of the right hand toward the left. *(Operator moves the right track in reverse, while moving forward with the left track.)*

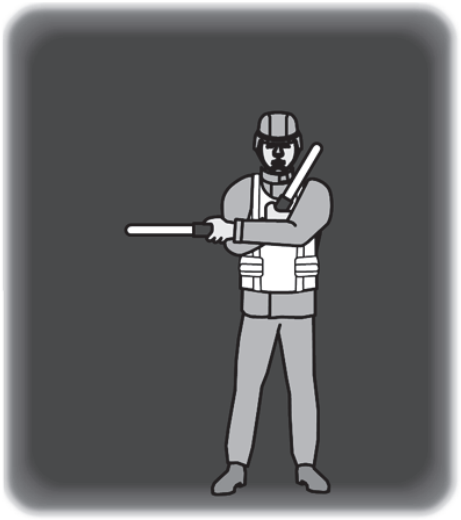


NEUTRAL STEER RIGHT, Track Vehicles (Night): Place the left wand against the right side of the neck. Extend the right arm horizontally toward the direction of travel, with the wand pointed to indicate which way to turn.

Figure G-10. Signal for neutral steer right



NEUTRAL STEER LEFT, Track Vehicles: Cross the right wrists beside the neck with clenched fist. Point the index finger of the left hand toward the right. *(Operator moves the left track in reverse, while moving forward with the right track.)*

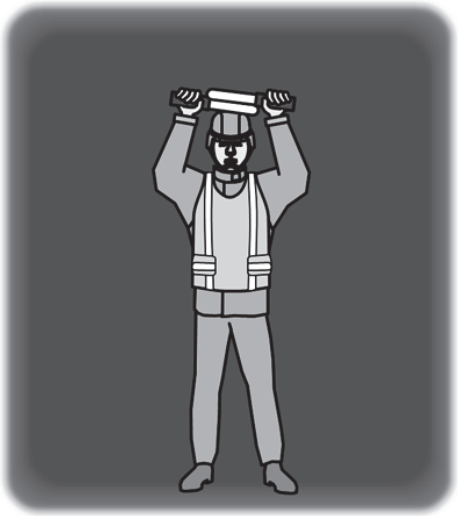


NEUTRAL STEER LEFT, Track Vehicles (Night): Place the right wand against the left side of the neck. Extend the left arm horizontally toward the direction of travel, with the wand pointed to indicate which way to turn.

Figure G-11. Signal for neutral steer left



BUTTON-UP: Place both hands on top of the helmet, palms down, one on top of the other. Have the arms and elbows back on the same plane as the body.

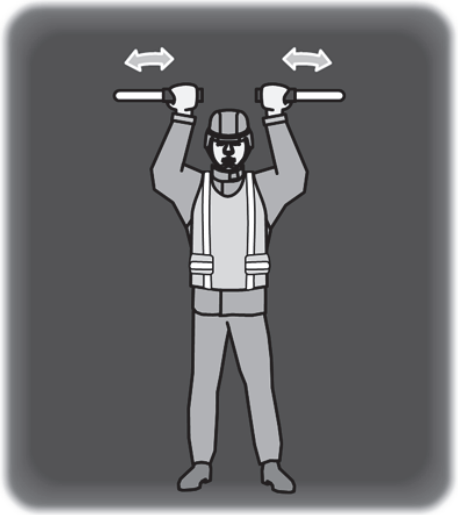


BUTTON-UP (Night): Place both wands on top of the helmet, one on top of the other. Have the arms and elbows back on the same plane as the body.

Figure G-12. Signal for button-up



UNBUTTON: Start from the button-up signal; then separate the hands, moving them slightly back and forth in a slicing motion. Have the arms and elbows back on the same plane as the body. Repeat as needed to ensure having the driver's attention.

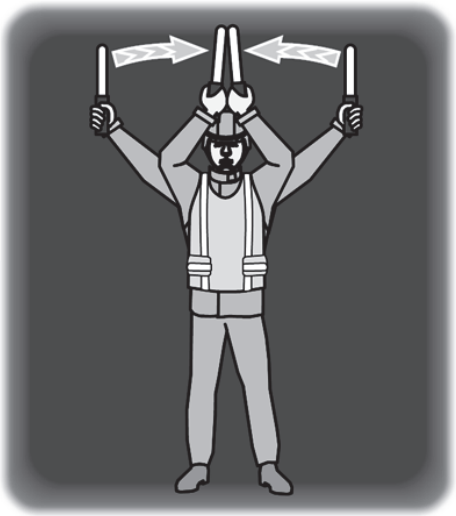


UNBUTTON (Night): Start from the button-up signal; then swing the wands outwards, moving them slightly back and forth in a slicing motion. Repeat as needed to ensure having the driver's attention.

Figure G-13. Signal for unbutton



CLOSE THE DISTANCE & STOP: This Far To Go - Extend the forearms to the front, palms inward and separated (to about 3 or 4 feet of width). Bring palms together as the crane approaches the target stop point. The crane stops when palms come together.



CLOSE THE DISTANCE & STOP (Night): This Far To Go - Extend the wands over head, tips pointed upward and separated (to about 3 or 4 feet of width). Bring wands together as the crane approaches the stop point. The crane stops when wands touch, or flip to Stop signal.

Figure G-14. Signal for close the distance and stop



EMERGENCY STOP: Raise either arm with clenched fist. The other hand may point to the cause for the emergency. *(Only for use when the guide sees a safety issue or threat to the operation.)*

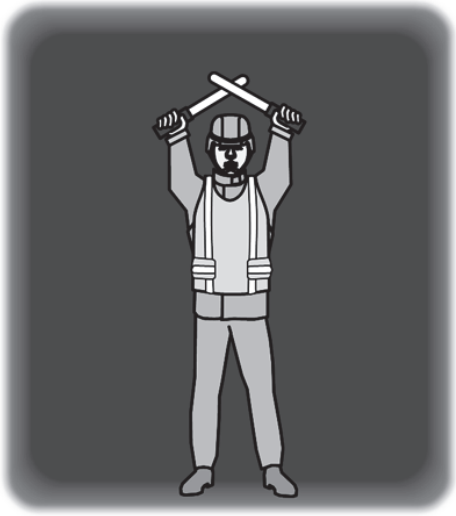


EMERGENCY STOP (Night): Raise either arm with wand held horizontally. Place the other hand with wand held diagonally across the chest. The other hand may briefly point to the cause for the emergency, but must repeatedly return to the chest.

Figure G-15. Signal for emergency stop



STOP: Clasp hands together palm to palm just below the chin.

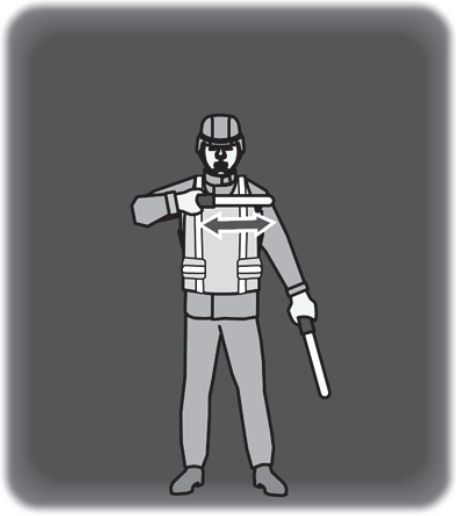


STOP (Night): Cross wands over the head.

Figure G-16. Signal for stop



STOP ENGINES: Extend an arm horizontal under the chin, hand open, palm down, and move the arm across the body in a throat-cutting action.

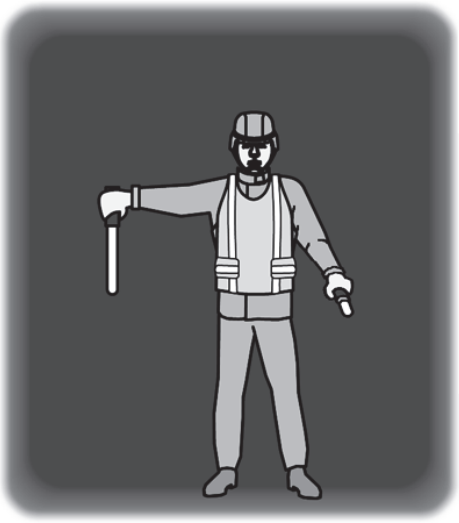


STOP ENGINES (Night): Hold a wand horizontal under the chin, and move the arm across the body in a throat-cutting action.

Figure G-17. Signal for stop engine



LOWER SPADE/OUTRIGGERS: First, point at the spade with the index finger of the left hand. Then, extend the right arm to the side, clenching a fist, and point the thumb downward.

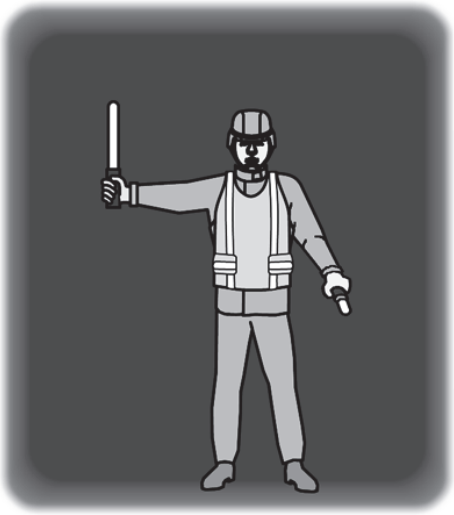


LOWER SPADE/OUTRIGGERS (Night): First, point at the spade with the wand of the left hand. Then, extend the right arm to the side, and point the right wand downward.

Figure G-18. Signal for lower spade or outriggers



RAISE SPADE/OUTRIGGERS: First, point at the spade with the index finger of the left hand. Then, extend the right arm with the arm slightly bent upward at the elbow while clenching a fist, and point the thumb upward.



RAISE SPADE/OUTRIGGERS (Night): First point at the spade with the wand of the left hand. Then, extend the right arm to the side, and point the right wand upward.

Figure G-19. Signal for raise spade or outriggers



PAYOUT THE WINCH CABLE: With the arm bent, bring the hand in front of the chest. Move the hand down and away from the body at belt level, circling back to the chest. The circular motion is continued until the stop signal is given.



PAYOUT THE WINCH CABLE (Night): With the arm bent, bring the wand in front of the chest. Move the wand down and away from the body at belt level, circling back to the chest. The circular motion is continued until the stop signal is given.

Figure G-20. Signal for payout the winch cable



INHAUL THE MAIN WINCH CABLE: Point at the operator with the index finger and rotate the arm in circular motion.



INHAUL THE MAIN WINCH CABLE (Night): Point at the operator with the wand, and rotate the arm in circular motion.

Figure G-21. Signal for inhaul the main winch cable

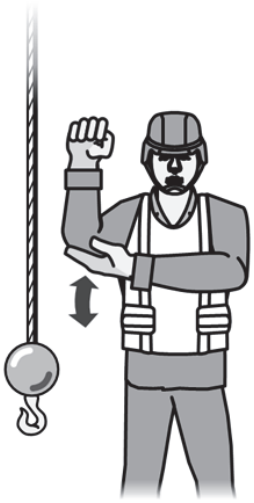


USE MAIN LINE: Tap the top of the helmet with the forefinger, three or four times.

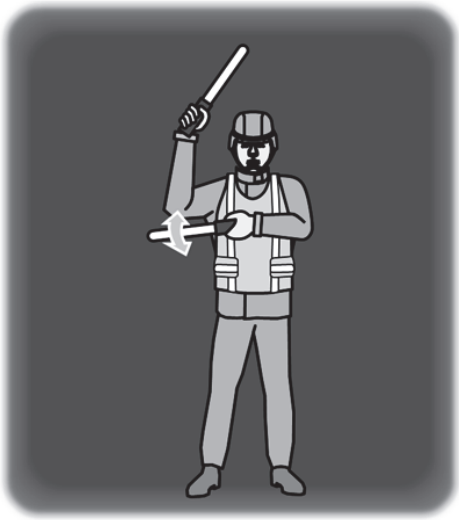


USE MAIN LINE (Night): Tap the top of the helmet with the tip of the wand, three or four times.

Figure G-22. Signal for use the main line



USE WHIP LINE: Tap the elbow of the raised forearm, three or four times.



USE WHIP LINE (Night): Tap the elbow of the raised forearm, three or four times with the wand.

Figure G-23. Signal for use the whip line



RETRACT THE BOOM: Extended the index and center fingers upward, with the back of the hand facing the operator. Move the hand in toward and a way from the chest, bending the elbow slowly in a pumping action.



RETRACT THE BOOM (Night): Hold the wand against the chest, with the lighted end touching the chest. Move the wand away from the chest and back again, bending at the elbow slowly in a pumping action.

Figure G-24. Signal for retract the boom



EXTEND THE BOOM: Extend the index and center finger upward, with the palm of the hand facing the operator. Move the hand away from the chest and back again, bending at the elbow slowly in a pumping action.

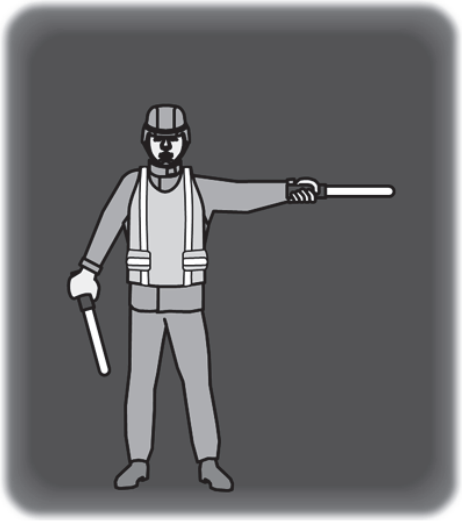


EXTEND THE BOOM (Night): Hold the wand against the chest, with the lighted end pointing outward. Move the wand away from the chest and back again, bending at the elbow slowly in a pumping action.

Figure G-25. Signal for extend the boom



SWING BOOM, RIGHT: Extend the left arm to shoulder level, with the whole hand pointing in the direction that the operator must traverse.

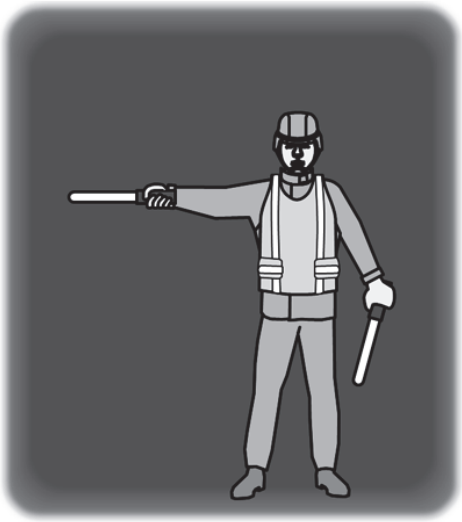


SWING BOOM, RIGHT (Night): Extend the left arm to shoulder level, holding the wand horizontal in the direction that the operator must traverse.

Figure G-26. Signal for swing the boom to the right



SWING BOOM, LEFT: Extend the right arm to shoulder level, with the whole hand pointing in the direction that the operator must traverse.

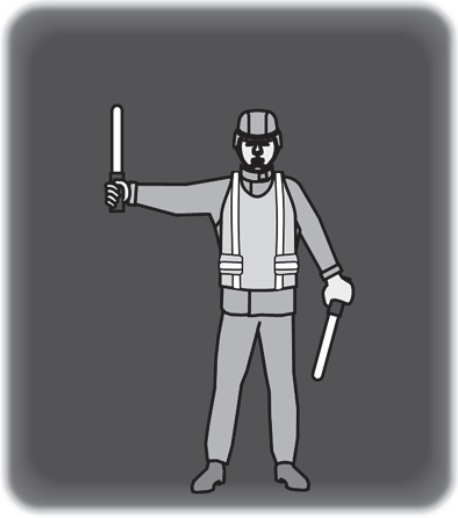


SWING BOOM, LEFT (Night): Extend the left arm to shoulder level, holding the wand horizontal in the direction that the operator must traverse.

Figure G-27. Signal for swing the boom to the left



RAISE THE BOOM: Extend an arm to the side, with the fist clenched, and point the thumb upward. This signal may be made with either hand.



RAISE THE BOOM (Night): Extend an arm to the side, with wand pointed upward. This signal may be made with either hand.

Figure G-28. Signal for raise the boom



LOWER THE BOOM: Extend the arm to the side, with the fist clenched, and thumb pointed downward. This signal may be made with either hand.



LOWER THE BOOM (Night): Extend an arm to the side, with wand pointed downward. This signal may be made with either hand.

Figure G-29. Signal for lower the boom



RAISE THE HOIST CABLE: Hold out the arm to the side, bent upward at the elbow, and extend the index finger from a fist. Rotate the hand slowly. This signal may be made with either hand with rotation made in either direction.

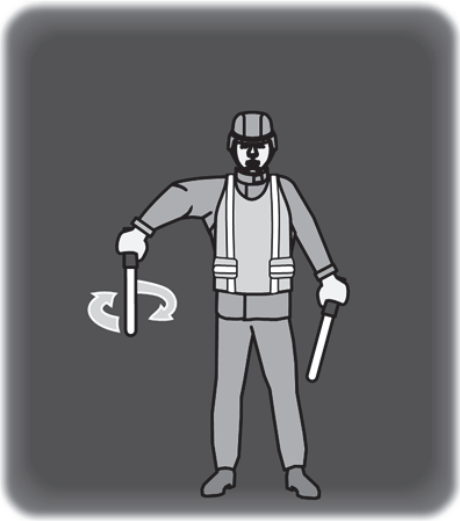


RAISE THE HOIST CABLE (Night): Hold out the arm to the side, bent upward at the elbow, and point the wand upward. Rotate the hand slowly. This signal may be made with either hand with rotation made in either direction.

Figure G-30. Signal for raise the hoist cable

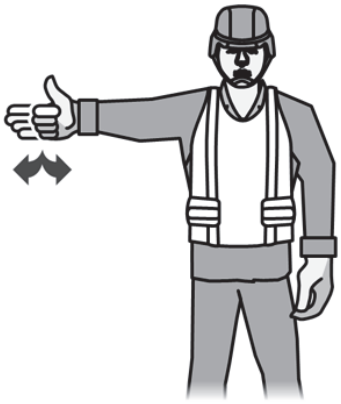


LOWER THE HOIST CABLE: Hold the arm downward and out slightly from the side, extend the index finger from a fist, and rotate the hand slightly. This signal may be made with either hand with rotation made in either direction.



LOWER THE HOIST CABLE (Night): Hold the arm downward and out slightly from the side, with the wand pointed down, and rotate the wand slightly. This signal may be made with either hand with rotation made in either direction.

Figure G-31. Signal for lower the hoist cable



RAISE BOOM & LOWER THE LOAD: Extend arm, thumb pointed up, flex fingers in and out as long as load movement is desired. *(This moves the load horizontally toward the crane.)*



LOWER BOOM & RAISE THE LOAD: Extend arm, thumb pointed down, flex fingers in and out as long as load movement is desired . *(This moves the load horizontally away from the crane.)*

(There is no night time signal for conjoined Hoist & Boom movement.)

Figure G-32. Signal for raise boom, lower load & lower boom, raise load





MOVE SLOWLY: Use one hand to give any motion signal, and hold the other hand motionless palm down just above the signaling hand (e.g., Hoist UP - Slowly, and Swing Boom Right - Slowly).

(There is no night time conjoined signal for movement and move slowly.)

Figure G-33. Signal for move slowly

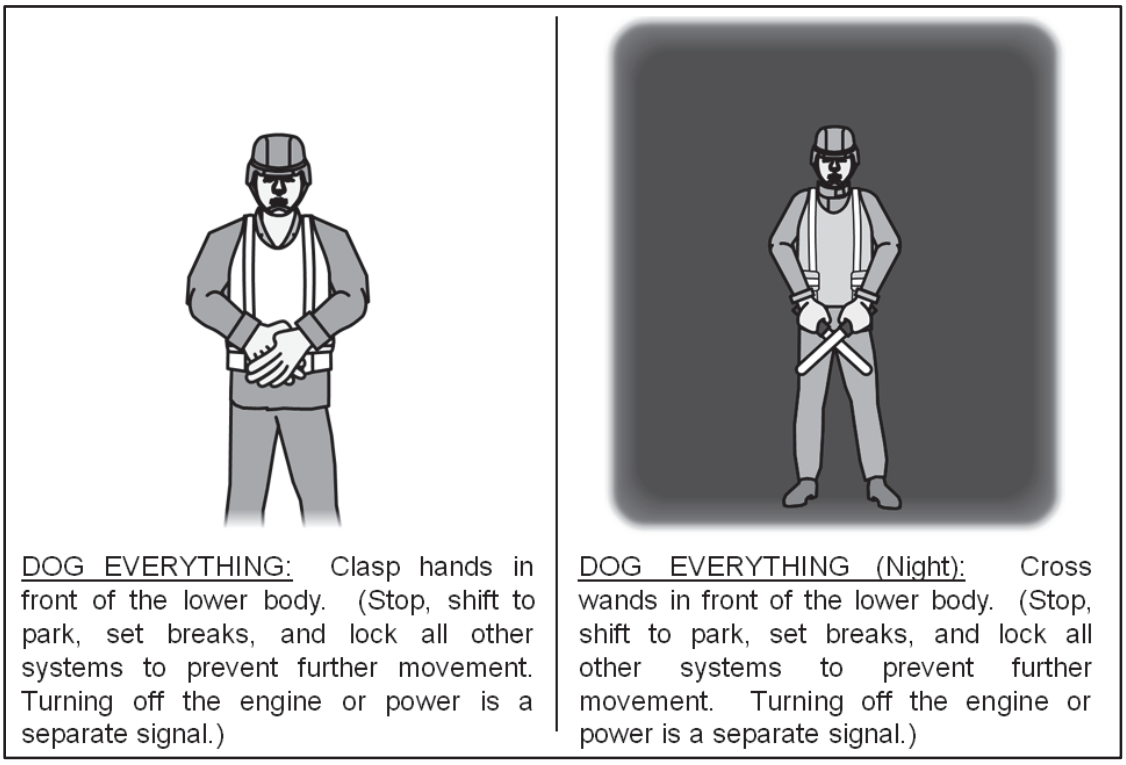


Figure G-34. Signal for dog everything

Overhead Power Lines

G-31. Wreck crane operations under or near electric power lines are extremely hazardous. A closed electric circuit and a difference in voltage are required for the passage of electric current. When a crane boom or cables come in contact with a live power line, the crane, cables, boom, and load become electrically charged. A person on the ground steadying a swaying load or touching any part of the crane becomes part of this closed electric circuit and can be instantly electrocuted or be critically burned. The crane operator is responsible for keeping the crane boom and cables away from power lines. The operator is relatively safe while in the cab. Should the operator step off the crane and have one foot on the crane step and one on the ground, they could be electrocuted or burned.

Movement in Tow

G-32. Wreck cranes are powered for independent movement by gear-driven wheels. When cranes are moved in tow, in work or wreck trains, operators must take the following precautions to avoid damage to the crane, the train, or wayside objects:

- Secure the rotating deck parallel to the centerline of the track.
- Fasten the deck at front and rear ends with tie bars provided.
- Lower the boom to the traveling position, preferably pointing to the rear.
- Place transmission lever in NEUTRAL position.
- Disengage driving gears so wheels will turn freely.
- Use hand crank to draw the gear assemblies out of mesh.

Safe Load Precautions

G-33. Cables and tackle must not be overloaded. When making heavy lifts, crane or derrick operators must be sure of the following:

- Boom is properly positioned.
- Boom is as high as possible.
- Hoist cables have greater capacity than the load to be lifted.
- Hoist cables have no kinks or broken wires.
- Crane is level and outriggers are in place.
- Brakes are in good working order.
- Load to be lifted is properly slung (rigged).
- Load is kept near the ground when traveling and not lifted higher than necessary.
- The swing is started slowly when swinging loads.
- Loads are not left hanging on the hook.

SAFETY FACTORS

G-34. The ***safety factor*** **is the ratio of the strength of the rope to the working load.** For example, a wire rope with the strength of 10,000 pounds and a total working load of 2,000 pounds would be operating with a safety factor of 5. It is not possible to set exact safety factors for cranes with various types of wire rope as this factor can safely vary with conditions. The proper safety factor depends not only on the loads applied, but also on the following:

- Speed of operation.
- Type of fittings used for securing the rope ends.
- Length of the cable.
- Acceleration and deceleration.
- Number, size, and location of sheaves and drums.

G-35. The safety factors given in table G-1 have been established, by experience, as the minimum required for an average operation. Larger safety factors are desirable for greater safety and more efficient operation.

Table G-1. Safety factors.

Use	***Minimum Safety Factor***
Guys	3.5
Miscellaneous hoisting equipment	5.0
Derricks	6.0
Slings	8.0

LOAD FORMULAS

G-36. Safe working loads are selected from mathematically determined tables (tables G-2 and G-3 on page G-24). However, the following formulas are rule of thumb methods for determining safe working loads (in STONs) for hooks, chains, ropes, and cable (diameter in inches):

- Hooks. Where the hook starts to arc, the square of the diameter.
- Chains. Eight times the square of the diameter of one side of the link.
- Rope. Square of the diameter.
- Cable (wire rope). Eight times the square of the diameter.

Table G-2. Safe working loads for slings-part 1

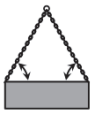
Chain Slings (Loads in Pounds)								
	SINGLE	*DOUBLE*						
Size of Chain (inches)								
		When Angle is						
		5º	10º	15º	20º	30º	45º	60º
3/8	2700	470	940	1450	1850	2700	3800	4700
7/16	3450	600	1200	1750	2350	3450	4900	5900
1/2	4500	780	1570	2300	3100	4500	6350	7800
5/8	6900	1200	2400	3550	4700	6900	9750	12000
3/4	10100	1750	3500	5200	6900	10100	14000	17500
7/8	14000	2400	4900	7250	9600	14000	19500	24000
1	18600	3200	6500	9650	12700	18600	26000	32000
1 1/8	23400	4000	8000	12000	16000	23400	33000	40000
1 1/4	28800	5000	10000	15000	19700	28800	40500	50000
1 3/8	34500	6000	12000	17800	23500	34500	49000	60000
1 1/2	40800	7000	14000	21000	28000	40800	57500	70000

Table G-3. Safe working loads of slings-part 2

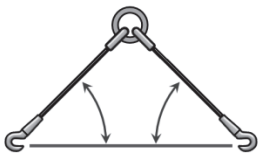
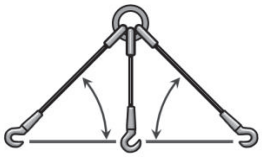
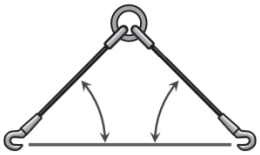
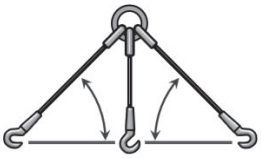
Wire Rope Slings (Loads in Pounds)							
	SLIP NOOSE	*TWO-END BRIDLE SLING*			*THREE-END BRIDLE SLING*		
Size of Rope (inches)							
		When Angle is			*When Angle is*		
		45º	*60º*	*75º*	*45º*	*60º*	*75º*
3/8	3200	2200	2800	3000	3400	4200	4600
1/2	5400	4000	4800	5200	6000	7200	7800
5/8	8400	6000	7200	8000	9000	10800	12000
3/4	12000	8400	10200	11400	12600	15400	17000
7/8	16000	11400	14000	16000	17200	21000	24000
1	22000	15000	18000	20000	22000	26000	30000

Table G-3. Safe working loads of slings-part 2 (*continued*)

Wire Rope Slings (Loads in Pounds)							
	SLIP NOOSE	***TWO-END BRIDLE SLING***			***THREE-END BRIDLE SLING***		
Size of Rope (inches)							
		When Angle is			***When Angle is***		
		45º	***60º***	***75º***	***45º***	***60º***	***75º***
1 1/8	26000	19000	23000	26000	28000	36000	40000
1 1/4	32000	23000	28000	32000	36000	42000	48000
1 3/8	40000	28000	34000	38000	42000	52000	58000
1 1/2	46000	32000	40000	44000	48000	60000	66000

NOTES:
- Loads are based on slings in good condition.
- Take up slack and start the load slowly.
- Keep slings free from twists, knots, and kinks.
- Lift from the center of hooks, never from the point.
- Distribute the load evenly on all legs of the sling.
- Inspect slings regularly.

DO NOT OVERLOAD.

HOISTING AND LIFTING MATERIALS

G-37. Standard wire rope (cable) is used on wreck cranes for hoisting. Manila or sisal rope, because it is easy to handle, is carried for hand or tag lines, minor lashing, and rigging. All spare rope (both fiber and wire) should be kept coiled when not in use. The sizes of rope used by the U.S. Army are designated as inches in diameter.

FIBER ROPE

G-38. Fiber rope is made by twisting vegetable fibers together. The rope consists of three elements: fibers, yarns, and strands. The direction of twist of each element is reversed to prevent the elements from unraveling under load strain. Fiber rope is named for the kind of vegetable fibers of which it is composed. Manila rope (made from the fibers of plantain leaves) and sisal rope (made from the fibers of aloe leaves) are two types commonly used in military service. Manila rope is superior to other fiber ropes in elasticity, strength, and wear qualities. It is smooth and runs well over blocks and sheaves.

G-39. The minimum breaking strength of manila and sisal rope is much greater than their safe working capacity. The difference between the two is the safety factor. The safe working capability (in STONs) for a given size of manila rope is approximately equal to the square of the diameter in inches, using a safety factor of four. Under no circumstances should fiber rope be loaded to more than twice its rated safe working capacity. As rope deteriorates, the safe load is one-half of the value shown in table G-4 on page G-26.

Table G-4. Properties of manila and sisal rope

Nominal diameter (inches)	*Circumference (inches)*	*No. 1 Manila*		*Sisal*	
		*Breaking strength (STONs)**	*Safe load (STONs)* FS = 4*	*Breaking strength (STONs)*	*Safe load (STONs) FS = 4*
¼	¾	0.27	0.07	0.22	0.06
½	1 ½	1.32	0.33	1.06	0.26
¾	2 ¼	2.70	0.67	2.16	0.54
1	3	4.50	1.12	3.60	0.90
1 ¼	3 ¾	6.72	1.69	5.40	1.35
1 ½	4 ½	9.25	2.31	7.40	1.85
2	6	15.50	3.87	12.40	3.10
3	9	32.00	8.00	25.60	6.40
* Breaking strength and safe loads are for new rope used under favorable conditions.					

WIRE ROPE

G-40. Wire rope is made of steel or iron wires twisted to form strands. The strands may be wound around each other or twisted over a central core of fiber or steel rope. The direction of twist of each element of the rope is known as the lay of that element. Regular lay, the accepted standard for wire ropes, denotes ropes in which the wires are twisted in one direction to form the strands. Strands are twisted in the opposite direction to form the rope. In regular lay ropes, the wires are almost parallel to the longitudinal axis of the rope. Due to the difference in direction of the strand and rope lays, regular lay ropes are less likely to kink and untwist than ropes constructed with other lays. They are also easier to handle. Overloaded wire cable breaks a strand at a time. To prevent corrosion and internal abrasion, boom wire rope should be lubricated with lubricants thin enough to penetrate to the inner strands.

G-41. Fiber cores are standard for most constructions of wire rope, but are not as strong as ropes with wire cores. A fiber core supports the strands, supplies internal lubrication, and contributes to the flexibility and resiliency of the rope. Wire core ropes are less suitable than fiber core ropes for operations where shock loads are frequent. Wire rope constructions are designated by the number of strands in the rope and the number of wires in each strand. Therefore, a rope composed of six strands of 19 wires each is a 6 x 19 rope. This is the standard hoisting cable and is more universally used than any other rope construction.

CHAINS

G-42. Chains are composed of a number of metal links connected together. The links are made of a round or oval piece of rod or wire welded into a solid ring after being joined to the connecting link. Chain size is determined by the diameter of the rod composing the links. While chains may stretch under excessive loads, individual links will bend only slightly. Chains with bent links may suddenly fail under load and break. Since chains are resistant to abrasion, they are often used to lift heavy objects with sharp edges that might cut wire rope.

BLOCKS

G-43. A block is a shell or frame, which holds one or more grooved pulleys, called sheaves. The sheaves revolve on a center pin or axle. A swivel-type hook is attached to one end of the block and often an eye is attached to the other.

Types of Blocks

G-44. Block sizes are determined by the length of the shell (frame) in inches and by the number of sheaves it contains. Single, double, triple, and quadruple blocks contain one, two, three, or four sheaves respectively. Blocks can be identified by their construction and the manner in which they are used. These two types of blocks are conventional and snatch.

- **Conventional** block. A conventional block is constructed of fiber or wire rope, which must be reeved or threaded through the sheaves. This is the type block found on crane booms.
- **Snatch** block. A snatch block, also called a gate block, is constructed so that one side opens to permit a cable or rope to be placed over the sheave without reeving through the block. It is easily identified by the hinge and lock on one side. It is normally used in making rigs to obtain mechanical advantage where the cables or ropes are continuous lines and cannot be threaded through the sheave.

Classification

G-45. Blocks are classified according to the manner in which they are used. These two types of blocks are fixed and running.

- **Fixed block.** This block is fastened to a stationary object. It does not affect mechanical advantage. Sometimes called a leading block, it does permit a change in direction of the cable.
- **Running block.** This block (also called a traveling block) is fastened to the object to be moved or lifted. This block does not produce a mechanical advantage.

CABLE

G-46. The largest size cable or rope that can be used on a block is determined by the diameter of the sheave, depth of the groove, and the size of the opening through which the line passes over the sheave. The proper size is the largest one possible that fits the sheave groove and still has clearance between the frame and the sheave. This diameter is usually from one-eighth to one-ninth the shell length. The use of multiple sheave blocks increases the weight that can be lifted (mechanical advantage). This increase depends on the number of sheaves in the sheave blocks and the number of parts of cable between the blocks.

HOOKS

G-47. Railway wreck cranes are equipped with two standard slip hooks (one large and one small). The large hook is rigged to the triple block on the main boom hoist. On steam cranes, the small, single hook is rigged to the single-hoist line over the sheave at the end of the boom. Slip hooks are made so the inside curve of the hook is an arc designed to be used with wire or fiber rope and chains. Hooks usually fail by straightening, thereby releasing the load. Any deviation from a perfect inner arc indicates overloading. Safe working loads of drop-forged steel hooks of various sizes are shown in table G-5.

Table G-5. Safe loads on hooks

Diameter at beginning of arc (inches)	*Inside diameter of eye (inches)*	*Length of hook (inches)*	*Safe load on hook (pounds)*
1	1 ¼	6-7 1/8	3,400
1 ½	1 ¾	10 11/32	8,000
2 ¼	2 ¾	14 13/16	13,600
3	3 1/2	19 3/4	24,000

CRANE RIGGING

G-48. Wreck crane rigging includes all the combinations of cable, rope, and tackle used to raise or move heavy loads. Rigging may be used to change the direction of pull or to take advantage of favorable terrain features. Various combinations of cables, blocks, and pulleys may be rigged to create mechanical advantage. To employ crane rigging effectively, wreck crew personnel must understand the various parts and how effort and resistance are distributed among them. When effort is exerted on one end of a cable or a rope, there is equal resistance applied at the other end. Tackle must be used if the resistance (object to be moved) exceeds the effort available. This difference is supplied by the mechanical advantage of rigging.

G-49. The heavy load (main) hoist raises and lowers the big block on the crane boom. The main hoist consists of a number of wire rope cables running from the load block up to the peak of the boom, through sheaves, and down to the main hoist drum in the crane cab. The number and size of cables vary with the lifting capacity

of the crane. The auxiliary hoist line raises and lowers the hook at the end of the boom. Cables for this line run through the sheaves of the light load hook to the sheaves at the tip of the boom, then to the auxiliary hoist drum. These cables vary with the lifting capacity of the light load hook.

EQUIPMENT RECOVERY AND LINE CLEARING OPERATIONS

G-50. The number of cars and locomotives off the track, whether they are upright or overturned, on the right-of-way or down an embankment, or in a ravine or a riverbed, are all factors in the equipment recovery and line clearing operations. Damaged equipment that is unable to move on its own wheels, is set aside for later recovery. The contents of cars must also be considered. Flammable and explosive ladings present certain safety hazards. Maintenance of way and signal maintenance personnel restores tracks and communication facilities that have been damaged. After traffic backlogs have been moved, the wrecked equipment can be picked up and evacuated to shops or salvaged by wreck trains operating in the traffic pattern. The division superintendent and other senior officers must consider the following factors when performing equipment recovery and line clearing operations:

- The military situation.
- Size and scope of the wreck.
- Density of traffic.
- Availability of personnel.
- Wreck cranes available.

RERAILERS

G-51. ***Rerailers*** **are cast iron devices used in simple derailments to retrack cars and locomotives.** Rerailers are carried on locomotives and wreck trains. Rerailers are made to fit over a rail with grooves and runways designed to guide car wheel flanges back onto the rail to the proper running position. Some rerailers are designed for use under either wheel; others are designed for use in pairs. Those designed for use under either wheel must be spiked to a crosstie to prevent slipping. The rerailer shown in figure G-35 is used in pairs. One of the paired rerailers guides the wheel on the outside of the rail (right side), over the rail to position. The other one (left side) guides the wheel on the inside of the rail into a flange position. All derailed cars are pulled onto the track when possible. If the coupling is too low or too far away for a secure connection, chains should be used. The rerailing devices shown have a tapered opening that fits against the outside web of the rail. A wedge is driven between the outside web and the rerail device. The wedge tightens against the rail and prevents the rerailer from slipping as a result of the thrust of the car wheel.

Note. Never attempt to rerail a diesel locomotive under its own power. Serious damage may result to traction motors from spinning wheels. Unloaded traction motors attain dangerously high speeds.

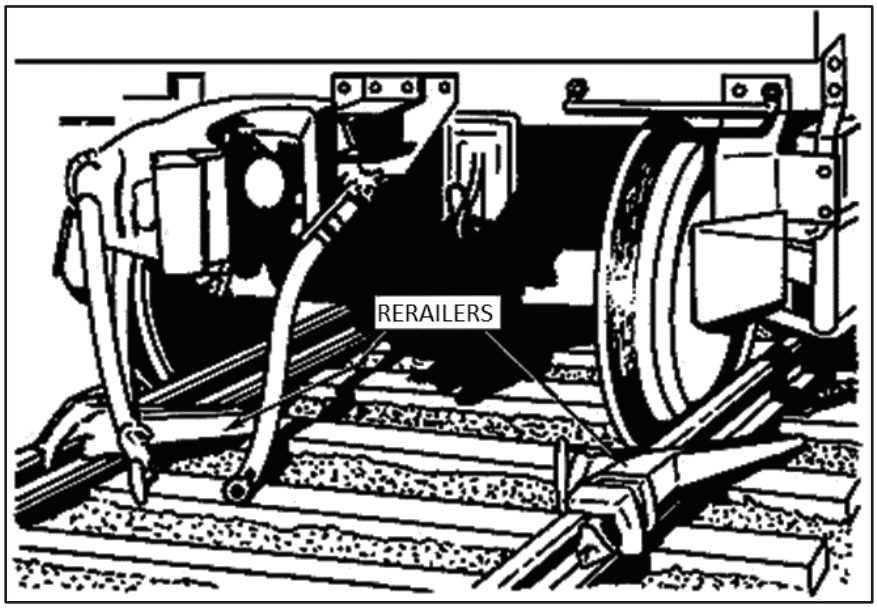


Figure G-35. Using rerailers to retrack a derailed car

OTHER EQUIPMENT

G-52. Mobile cranes and bulldozers may often be used effectively in clearing operations when derailments or wrecks occur in areas accessible from the road. In complicated derailments involving a large number of cars, mobile cranes and bulldozers may be used to move car bodies and car trucks within reach of the wreck crane. Mobile cranes may also be used to lift and load small items during clearing and salvage operations. Specially designed hydraulic jacks may be available to lift and rerail rolling stock. These are especially useful when minor obstructions must be cleared quickly.

PRELIMINARY PROCEDURES

G-53. It is not practical to list all specific instructions covering the different kinds of lifts that must be made under wreck conditions. The wreckmaster and other officials on the site must consider all factors and decide which action to take. Each wreck is different and proper lift procedures depend on the following before any recommendations can be applied to a particular wreck:

- Situation.
- Weather.
- Timing.
- Lifting hazards.
- Damage to equipment.
- Number and capacity of wreck cranes available.

PREPARATION FOR LIFTING

G-54. The total weight of the anticipated lift should be calculated as accurately as possible. This includes the weight of the material or object to be handled and the block, sling, or other devices between the hook and the load. The light weight of the railway car is stenciled on the side of the car. Net weights of the contents of loaded cars are available from train documents. The calculated total weight is checked against the officially tested capacity of the wreck crane. Crane operators must never operate any weight-handling equipment in excess of its rated capacity without specific authorization from the officer in charge of the operation.

Load Security

G-55. Loads should not be lifted or moved unless they have been hitched in such a way that no shifting of weight, slippage, or loss of load will occur. Incorrect rigging can damage lifting gear by breaking the fiber or wire of the cable. This can result in making subsequent lifts an increasingly hazardous operation.

Brake Tests

G-56. Heavy loads should be lifted a few inches off the ground and the load brakes tested to be sure they will hold before the load is raised any higher. Test-rated lifting capacities should always be checked to determine permissive loads. If the crane has been idle for a long time, hoist the load block to the boom several times with the brakes lightly applied before hoisting a heavy load. This will dry out any moisture in the brake lining. Excessive moisture in the brake lining will cause rough brake performance and could cause the load to drop.

Footing

G-57. Making a safe lift depends largely on having a firm foundation and a level base for the crane. The steel rails of the track usually provide a firm foundation, but a level base may require maximum use of the outriggers and blocking. Outriggers are used when making heavy lifts or when making lifts near the crane's maximum capacity at any radius. If blocking rests on a firm base, a small clearance must be allowed at points "A" (figure G-36). A level base is required to avoid swinging the load and to reduce the possibility of tipping. Level swinging requires a minimum of power and is fast and stable. Outriggers are securely extended and blocked before attempting near capacity lifts; footing must be level and solid. Outriggers are not extended beyond the crane manufacturer's recommended limits.

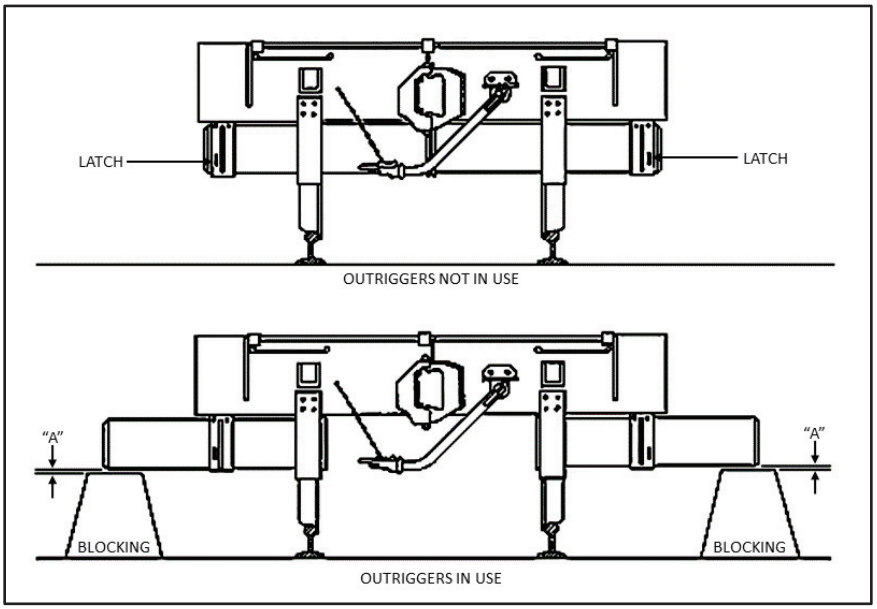


Figure G-36. Outriggers

Lifting the Load (Mechanical Advantage)

G-58. In order to lift a load beyond the strength and capacity of the person lifting it, the mechanical advantage must be determined. Mechanical advantage is determined by multiplying the force exerted by the force applied to lift or move a load. Mechanical advantage may be computed for simple and compound tackle systems.

Simple Tackle System

G-59. A simple tackle system (figure G-37) has one cable (rope) and one or more blocks. In this system (figure G-37, number 1), there are two lines leaving the load, the fixed end and the fall line (pulling line). The fall line is bearing the pulley. The force in the fixed line is P; the tension in the rope as it leaves the block is also P, so two forces, each equal to P, are lifting on the block. The total force being applied is 2P; therefore, the mechanical advantage is 2. In a simple tackle system with three lines leaving the block (figure G-37, number 2) the mechanical advantage is 3. In a simple tackle with two double blocks (figure G-37, number 3) and five lines leaving the load, the mechanical advantage is 5.

Compound Tackle System

G-60. A compound tackle system has more than one rope and two or more blocks. Compound systems are made up of two or more simple systems. The fall line from one simple system is fastened to a hook on the traveling block of another simple system that may include one or more blocks. In such a compound system, the force exerted on the fall line of one simple system is multiplied by the mechanical advantage of that system and applied to the fall line of the second simple system. This force is then multiplied by the mechanical advantage of the second simple system. In a compound system with five lines leaving the load (figure G-37, number 4) and the fall line of this tackle attached to a traveling block with two lines supporting it, the mechanical advantage is 2 times 5, or 10. A more complicated system is shown in figure G-37, number 5. This system is made up of two simple systems, each of which has four lines supporting the load. The traveling block of the first simple system is fastened to the fall line of the second simple system; the mechanical advantage of this compound system is 4 times 4, or 16.

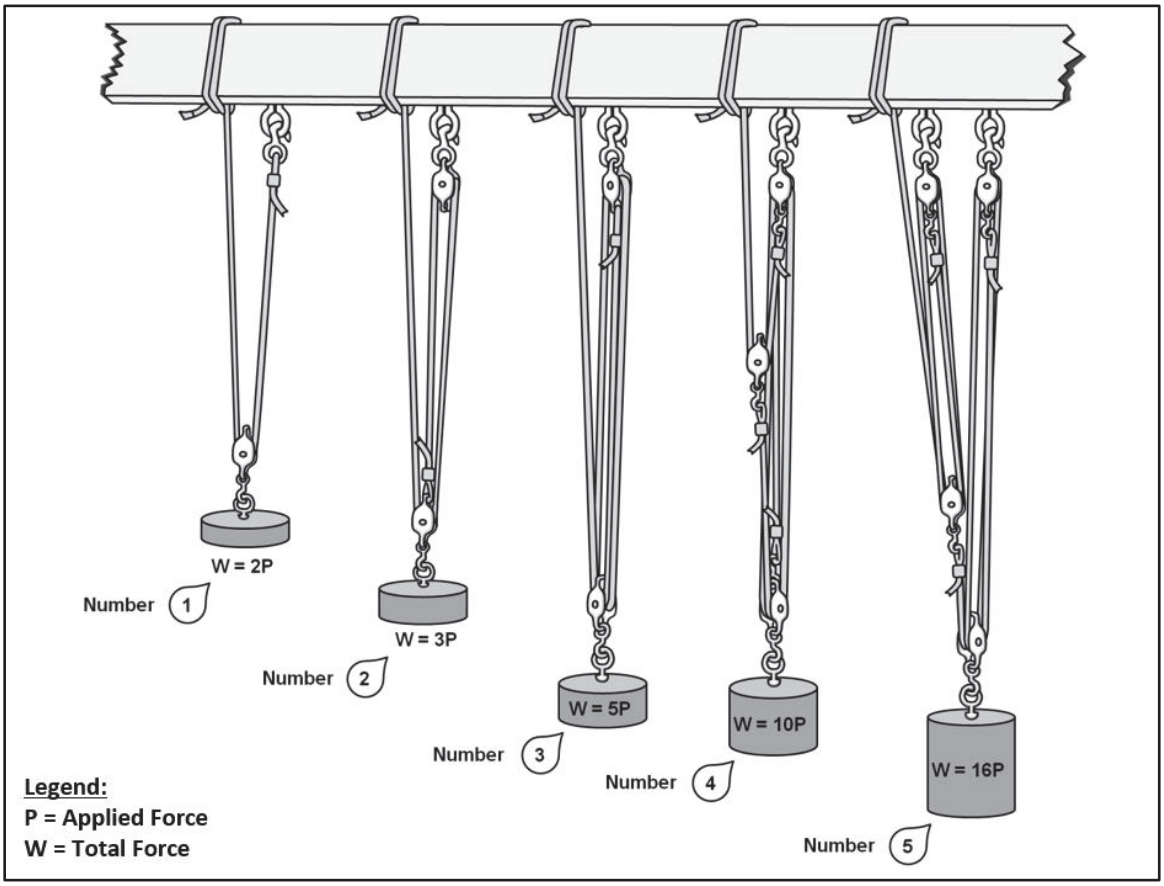


Figure G-37. Mechanical advantage of various tackle rigs

Deadman

G-61. A deadman provides anchorage for additional pulling power when secured to an inanimate object. The deadman may consist of a log, rail, steel beam, or other similar object buried as deeply in the ground as the force to be exerted requires (table G-6). The deadman has a guy line connected to it at the center. Where digging is not practicable, holdfasts made of pickets, cable, rope, girders, ground anchors, and so forth, may serve as anchorage for tackle hookups. Examples of these field expedients are shown in figure G-38, figure G-39, and figures G-40 through G-43 on page G-34.

Table G-6. Holding power of deadman in ordinary earth

Depth of anchorage (feet)	*Inclination of pull (vertical to horizontal) and safe resistance in deadman area (pounds per square foot)*				
	Vertical	*1-1*	*1-2*	*1-3*	*1-4*
3	600	950	1,300	1,450	1,500
4	1,050	1,750	2,200	2,600	2,700
5	1,700	2,800	3,600	4,000	4,100
6	2,400	3,800	5,000	5,800	6,000
7	3,200	5,100	7,000	8,000	8,400

Deadman Installation

G-62. The hole in which the deadman is to be buried should be deep enough to provide a good bearing in solid earth. The bank in the direction of the guy line should be undercut at an angle of 15 degrees from vertical timbers (figures G-38 and G-39). Stakes may be driven in the ground against the bank at the same angle to provide a solid bearing surface. A narrow, inclined trench (cableway) should be cut through the bank to the center of the deadman. A short beam or log should be placed under the guy line at the outlet of the inclined trench. The guy line must be fastened securely to the center of the deadman so the standing part of the line (the part of the line on which the pull occurs) leads from the bottom of the deadman. This method of fastening the guy line, plus the angle of the bank, reduces the tendency of the deadman to move upward out of the hole. The strength of the deadman depends partly on the strength of the log or beam used, but mainly on the holding power of the earth.

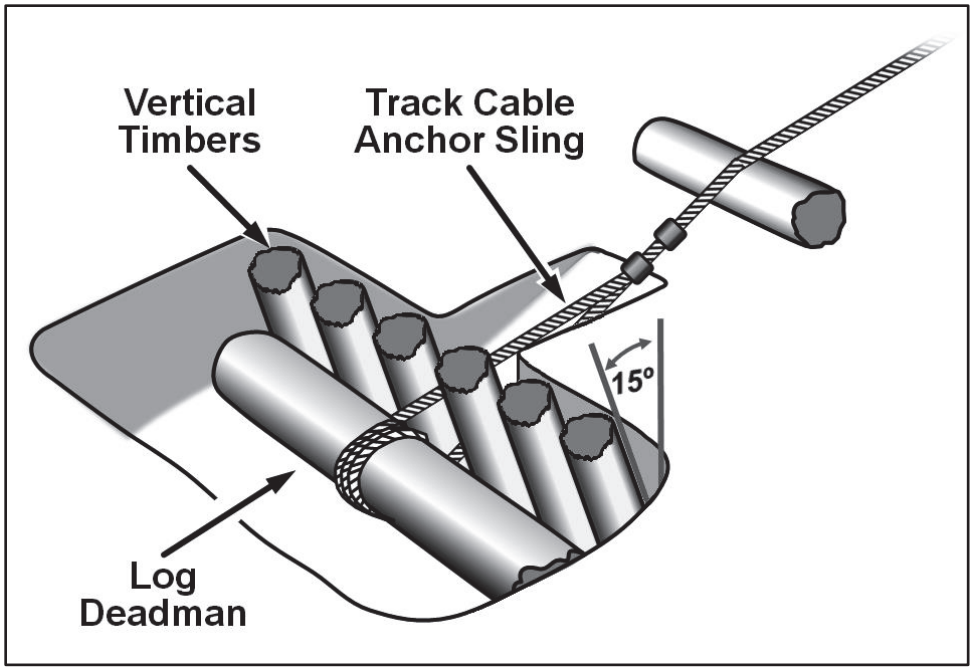


Figure G-38. Log deadman

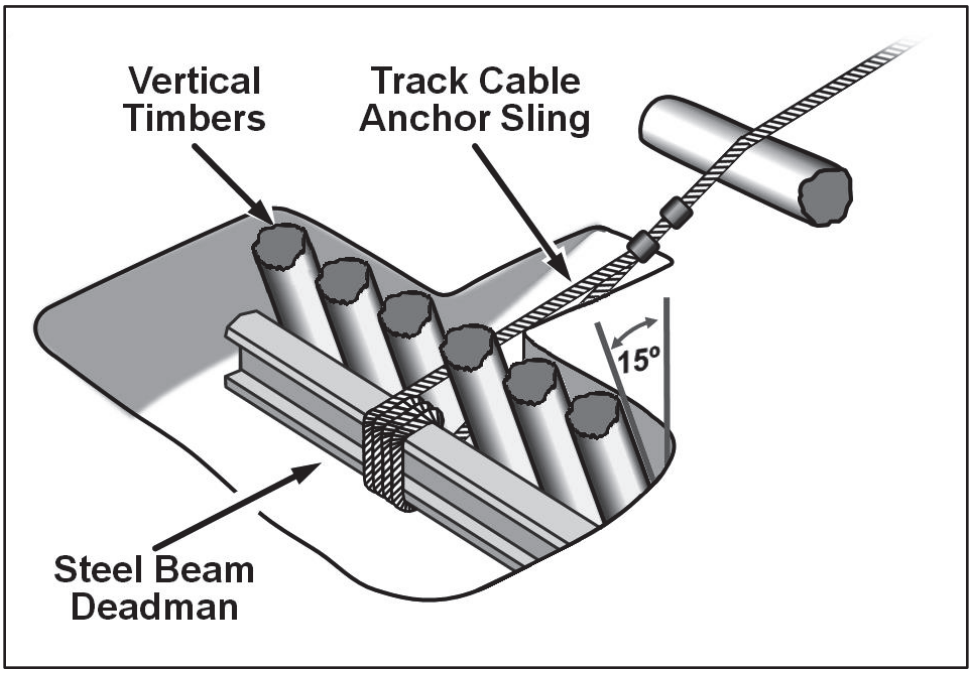


Figure G-39. Steel beam deadman

Picket Holdfast Installation

G-63. The strength of a picket holdfast depends on the following:

- How it is driven into the ground.
- The diameter and kind of stake used.
- The holding power of the ground.
- The depth to which the stake is driven.
- The angle of the stake.
- The angle of the guy line to the ground.

G-64. A combination steel picket holdfast provides more strength than wood and rope combinations (figure G-40 on page G-34). A multiple picket holdfast forms a stronger holdfast than does a single picket holdfast. To make a multiple holdfast, two or more pickets are driven into the ground in any desired combination and are lashed together (figures G-41 and G-42 on page G-34). The principal part of strength for a multiple picket holdfast is in the strength of the first (front) picket. To increase the surface area of the first picket against the ground, three pickets are driven into the ground close to each other and lashed together. They are then lashed to a second picket group that is lashed to a third picket (see figure G-42 on page G-34). Intervening pickets provide additional strength. Two trees used as natural anchorage are shown in figure G-43 on page G-34.

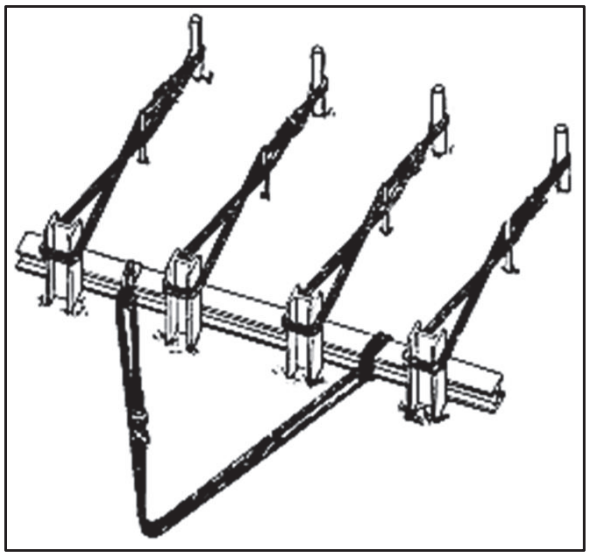


Figure G-40. Combination steel picket holdfast

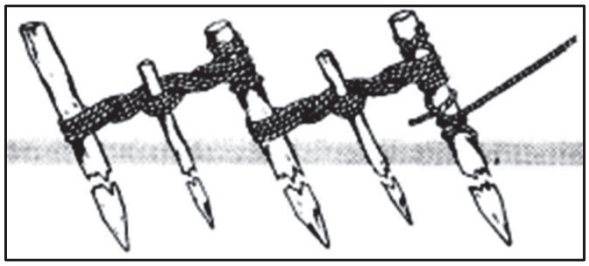


Figure G-41. Picket holdfast, 1-1-1 combination

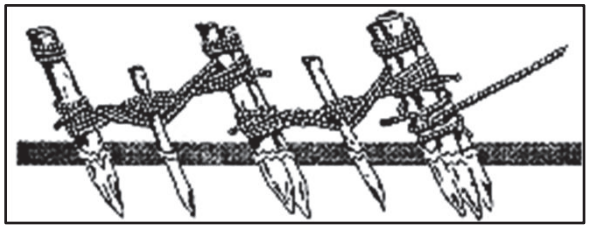


Figure G-42. Picket holdfast, 3-2-1 combination

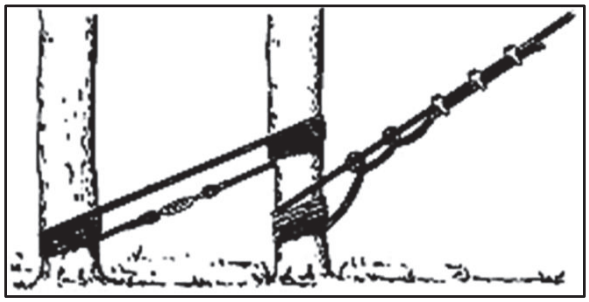


Figure G-43. Use of two trees as natural anchorage

Lifts

G-65. When repetitive lifting is required, position the crane so it has the shortest possible swing cycle in order to reduce cycle time. When multiple lifts are projected over an assigned area, position the crane so that it begins to work at the point farthest from the next direction of travel to a different area. Lifts are completed in one area before moving the crane to the next area.

Positions

G-66. Exact formulas and specific rules for positioning wreck cranes cannot be prescribed. Many factors determine crane working positions. The most undesirable position for lifting is with the boom at right angles to the crane body. This position is often required when clearing derailed or wrecked cars and locomotives to one side of the track. Outriggers are usually required when lifting capacity loads in this position. For heavy lifts, the crane should be positioned where it has the maximum lift capacity. When there are a number of loads to lift, it is best to position the crane so the loads can be lifted to the most remote points first. When in this position, the crane has greater boom clearance and subsequent crane operations are not blocked.

G-67. Each new job location or condition is checked for adequate boom clearance. During repetitive lifts, when work conditions remain unchanged, one thorough clearance check and careful continued observation will eliminate the need for raising and lowering the boom on each cycle. Wreck cranes are positioned, for safety reasons, so loads are not lifted over personnel or equipment. They are also positioned so they do not touch overhead obstructions (especially electric wires). Crane hooks are kept high enough so they will clear personnel and vehicles. Radius clearances are established by positioning the crane to provide adequate space between the load being handled and the point of final placement. Loads are hoisted high enough to ensure proper clearance, but no higher than necessary.

Resistance

G-68. When an overturned car or locomotive is to be rerailed, resistance must be overcome by force. This force is supplied by the crane and its rigging. In serious wrecks, cars and locomotives are often thrown some distance from the track. They must be dragged back to a lifting position, which may involve several forms of resistance. These forms of resistance are described below:

- Friction. Friction is created by the contact with an object being pulled across the ground. For example, the amount of friction the resistance offers by soft sand is less than gravel.
- Grade resistance. Grade resistance is determined by the weight of the object pulling downhill and the angle of the slope. By rule of thumb, grade resistance can be determined by multiplying one-sixteenth of the weight of the car or locomotive by the number of degrees of slope. An example of this is the resistance encountered when pulling an overturned car up an embankment to track level.
- Overturning resistance. That part of the weight of an object, such as that of a diesel locomotive, which acts against the force being exerted to get it upright and back on the track is overturning resistance. Half the weight of this object is the maximum that will ever be beyond the center of gravity from the point of lift, so only half of the weight is resisting recovery. When any overturned car or locomotive is to be set upright, the resistance is computed as one-half the weight of the object to be set up.
- Tackle resistance. Tackle resistance is a loss of energy or force that is created by the flexing of the cable of rope, the cable scuffing in the groove of the pulley or sheave, the sheave turning on the pin, and so forth. This loss (tackle resistance) must be overcome before the load can be moved. Each pulley or sheave in the tackle creates a resistance approximately equal to 10 percent of all the other resistance created by gravity, terrain, and so forth. If a standard 40- foot flatcar to be rerailed or picked up creates a resistance of 60,000 pounds and three sheaves are used in the tackle assembly (or crane boom), tackle resistance is 18,000 pounds (30 percent of 60,000 pounds).
- Total resistance. The total resistance that must be overcome before an object can be moved. Total resistance varies as conditions vary. For example, a car body weighing 20,000 pounds and dragged up a 6-degree, ice-covered slope would generate a total resistance of 2,800 pounds. The same object pulled over sand would create a total resistance of 5,000 pounds. An object dragged through mud or mire could create resistance equal to its own weight.

OPERATING TECHNIQUES

G-69. Precise rules and techniques cannot be given because of the diversity and wide range of jobs on which wreck cranes may be used. The experience and judgment of the wreckmaster and crane operator will dictate the procedures to be followed.

Cables

G-70. Cable breakage can cause serious injuries, loss of life, and property damage. Wire rope manufacturers recommend a safety factor of six for lifting operations. At full engine power, the safety factor on the crane hoist line of most free-moving cranes usually drops to about two. Do not load hoisting lines to the point where the engine begins to stall or use engine power as a gauge for safe line lifting capacity. If the engine is stalled by line pull only, flywheel inertia adds to rated power. A momentary increase in line pull to two and one-half times the full engine powerline pull will cause the cable to snap. Fast lowering with sudden stops will also overload hoist lines. Boom hoist lines usually encounter their heaviest loads when the load is just leaving the ground. At that point, the angle of lift is flat and there is considerable inertia in starting or stopping.

Working Radius

G-71. The general rule for working radius is the load should be handled at the shortest possible radius in keeping with job conditions, boom length, height of lift, and boom clearance at all points in the swing cycle. With a given boom length, the steeper the working angle, the shorter the working radius. The nearer the boom moves to the vertical position, the greater the loss in radius for each degree of increase in boom angle. Loads should not be hoisted higher than necessary and should be lowered as quickly as possible to the proper height for swinging, traveling, or spotting.

Boom and Hoist Control

G-72. Lifting the load up and down with a boom lengthens the lift cycle and increases wear and tear on the equipment. Hoisting is generally the best method. The following are the principal factors in controlled handling of loads:

- Speed.
- Smoothness of operation.
- Stability.
- Shock.
- Tipping.
- Feel of the load.
- Safety.

G-73. Using the boom, a careful operator will slightly lift the load and check to ensure that it is secure before lifting it completely off the ground. If not satisfied, the operator should lower the load and investigate and correct the condition. Speed is an element almost fully within the control of the operator. Due to centrifugal force, crane swing should be slow enough to avoid any outward throw of the load. The action of the crane hook at the end of a line is similar to that of a pendulum. Therefore, the hook can be controlled only at the slowest speeds. Tag lines are required for controlling the outward swing of free-moving cranes. When conditions permit, handlines are used to ease the load down and guide it into place. The hoist line is then eased off until the crane settles back gently to a stable position. In case the boom and the crane have rocked from the release of the load, the operator should inspect the cables on the boom and on the drums to ensure they are in place. The cables may have become wedged, damaged, or cut.

Block Positions

G-74. Before hoisting a load, the upper block is placed directly over the load to permit a vertical lift and to prevent the load from swinging or kicking out. Tag lines are used to increase load stability. Blocks are not pulled too close to the sheaves at any time. If the blocks come together and the hoisting continues, the hoist line may break. There must be adequate clearance between the block and point sheaves when lowering the

boom. If not, the hoist line will tighten up and break or wedge down through other cables on the drum. As a safety factor, at least two full wraps of cable should be on the drums whenever they are in operation.

CAR LIFTS

G-75. When lifting a car, the coupler is the quickest and most practical place to make a hitch. However, couplers must be properly blocked to prevent damage to the car body. Some cars have jack pads or lifting eyes built integrally into the frames. Cars not equipped with these features can be easily hoisted by passing cable slings under the car frame.

Car Trucks

G-76. Most car frames are braced so that trucks may be chained to the car frame and lifted with the car body. When the car body must be lifted off the trucks for quick clearance, brake rods must be disconnected manually or cut in two with an acetylene torch. Car trucks may be lifted intact, separately, or in any one of several ways. Quick, emergency lifts can be made by inserting chains or cable slings through the side frame openings.

Cars

G-77. When lifting a car for rerailing, cables may be placed around the body of a solid top car and underneath the trucks. Using this sling arrangement or a sling with an adjustable spreader bar gives more stability to the lift. This arrangement is also preferable to the coupler hitch. To prevent crushing the body of the car, gondolas or hoppers must be braced at the top. Bracing may also be required for solid top cars. A crosstie cut to the proper length may also be used as a brace. Most modern passenger cars have holes through the heavily braced collision posts at each end. These holes permit the use of hooks or slings for lifting. The use of slings for coupler lifts and method of blocking the coupler are shown in figure G-44. Because of the weight and construction of some nations' ambulance unit cars, coupler lifts are not used. Jacking pads and lift lugs are used in lifting the car.

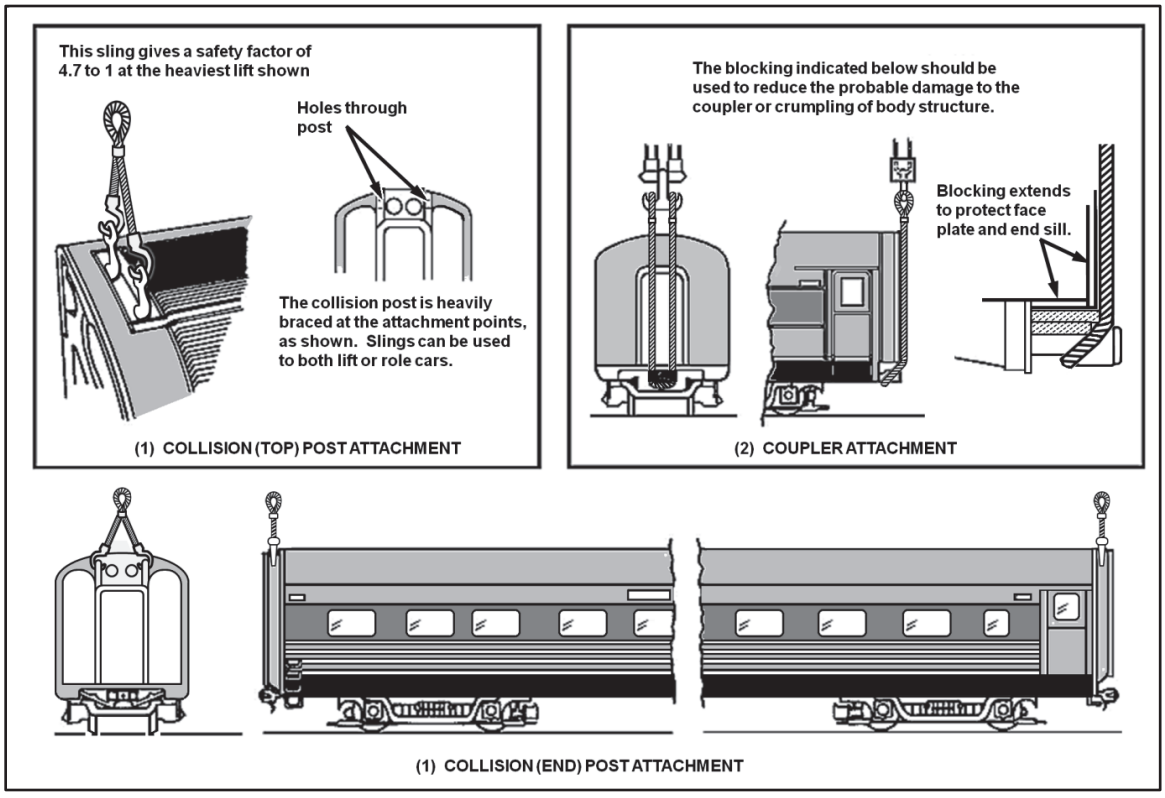


Figure G-44. Method of lifting passenger cars

LOCOMOTIVE LIFTS

G-78. Due to their weight, rerailing a diesel-electric or steam locomotive requires heavier and more careful rigging than that used for cars. Small locomotives may be lifted by a one-wreck crane using a spreader bar rig. Larger and heavier locomotives may require the use of two or three cranes. Depending on the type of truck and locomotive involved, removing the trucks of diesel-electric locomotives may decrease the lift required by 40 to 50 STONs. When it is necessary to roll or lift a locomotive that is some distance from the track and beyond the reach of the crane rope, extensions should be fastened with suitable connectors. These should be of the same size and quality as the crane cable.

LIFTING AND ROLLING

G-79. Two cranes, one at each end, should be used to roll a locomotive. Although a single crane large enough to handle the actual load and slings could be provided, an attempt to lift both ends at the same time could result in buckling the frame and crumpling the body structure.

Blocking

G-80. The body structure of a locomotive is heaviest directly over the bolsters. The load of the rolling operation can be carried best at these points. Adequate blocking is necessary to distribute the load. The amount of blocking necessary depends on the amount of roll required. If the locomotive is on its side and the cranes are pulling at a considerable angle, the entire top of the locomotive must be blocked to reduce damage (figure G-45, view 2). The major pull will be on this part of the structure during the initial rolling operation. As the locomotive approaches an upright position and the crane lift becomes more vertical, side blocking (shown in figure G-45, view 1) becomes more important.

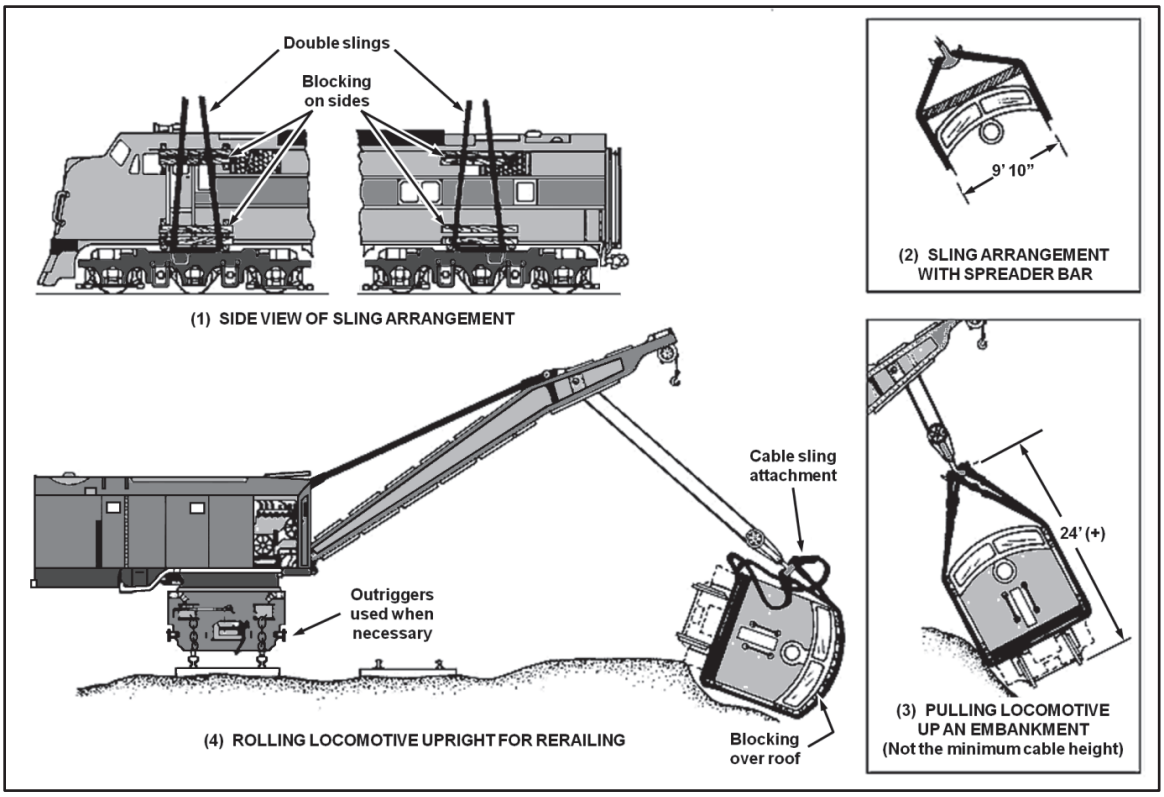


Figure G-45. Method of rolling diesel-electric locomotive upright—single crane

Rolling

G-81. Two slings are used for each end of the locomotive in a rolling operation. Each sling is passed from the hook down the side, around the centerplates, back to and up the side, and then back to the crane hook. The stress caused by rolling the locomotive falls on the underside sling at each end (figure G-45, view 3). When the roll is complete, the load is held by the four slings attached to the two cranes. Two slings are at each end of the crane. The load is now secure for either lifting or dragging. The method used when attaching two cranes to a locomotive, the sling positions when upright, and the minimum hook-to-rail height (24 feet) necessary to rerail the locomotive are shown in figure G-46. When possible, 24 feet of sling should be used to prevent the crane hook from bearing on the top of the locomotive when the locomotive is lying on its side. Using the sling also reduces the crushing action on the top sides of the locomotive after rolling is completed and actual lifting is begun. Where the lifting range of the wreck crane boom (or other conditions) does not permit a 24-foot clearance, a shorter cable rigs must be used.

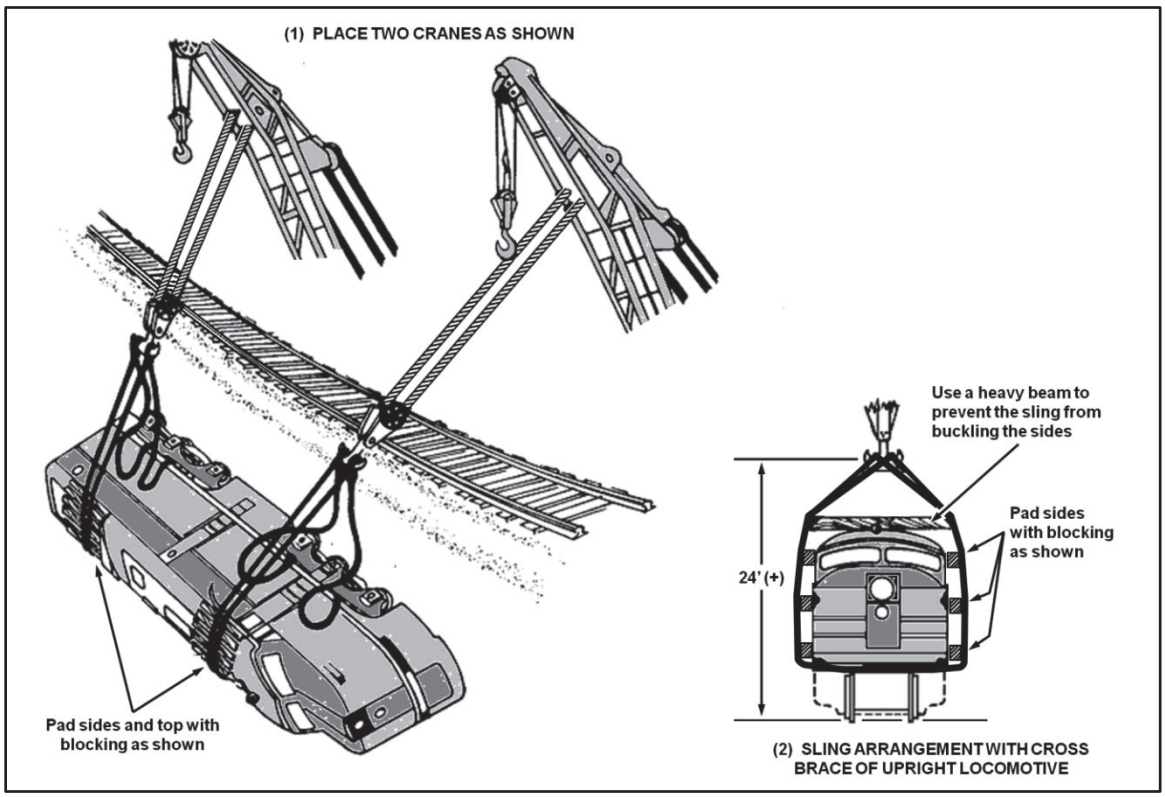


Figure G-46. Method of rolling diesel-electric locomotive upright—double crane

Other Precautions

G-82. Attach an extension cable to each underside sling to prevent the crane hook from bearing on the top of a rolling locomotive. This extension is removed when rolling is complete and before lifting starts. Use a load spreader when lifting a locomotive in the position shown in figure G-46, view 2. The crushing load at the top sides of the locomotive is approximately equal to the load to be lifted. The side blocking is not sufficient to protect the locomotive structure. Therefore, a suitable load spreader is placed over the top of the locomotive at each end to support the load. A load spreader can be any suitable wooden beam, such as a crosstie of proper length, notched at the ends to hold the slings against slippage.

Electro-Motive Division, Diesel-Electric Locomotive

G-83. All diesel-electric locomotive frames are designed to be supported at the bolsters. These frames can be strained or bent if the span between lifting points is too great. This is true whether the lifting slings are

attached to the lifting lugs, couplers, or jacking pads. Any commercial-type electro-motive division locomotive can be lifted at the extreme end (coupler hitch) if the other end is supported at the bolster. Military railway switcher type locomotives should be lifted only by the lugs. The special lifting bars and lugs are designed only for vertical lifting and should not be used to slide the locomotive.

Truck Centerplates

G-84. When only one end of a diesel-electric locomotive is to be lifted, place blocking between the truck and frame on opposite ends to prevent cracking the centerplates between the truck and bolster. The trucks are designed so that one end of the locomotive can be dropped below the rail height without damaging the liners on the truck remaining on the rail (as in simple derailments). If the derailed end is lifted excessively high, the liners are susceptible to damage. The clearance provided is enough to take care of normal deflections; but during rerailing, it is mostly absorbed by the deflection of the truck springs. Wreckmasters and crane operators must not lift one end of a locomotive more than 6 inches above the rail, unless the other end is lifted enough to separate the centerplates on its truck and bolster.

Lifting Lugs

G-85. All electro-motive division road switches equipped with lifting lugs on each side of frame bolsters. These lugs are designed to permit wire rope slings to be directly attached to the bolsters. When rerailing this type of locomotive, slings should have a minimum hook-to-rail clearance of 17 feet (figure G-47). Under normal conditions, two slings and a lifting bar are used on each end of the locomotive. In an emergency (and if properly blocked) one end of a switcher (up to 125-STONs) may be lifted at the coupler.

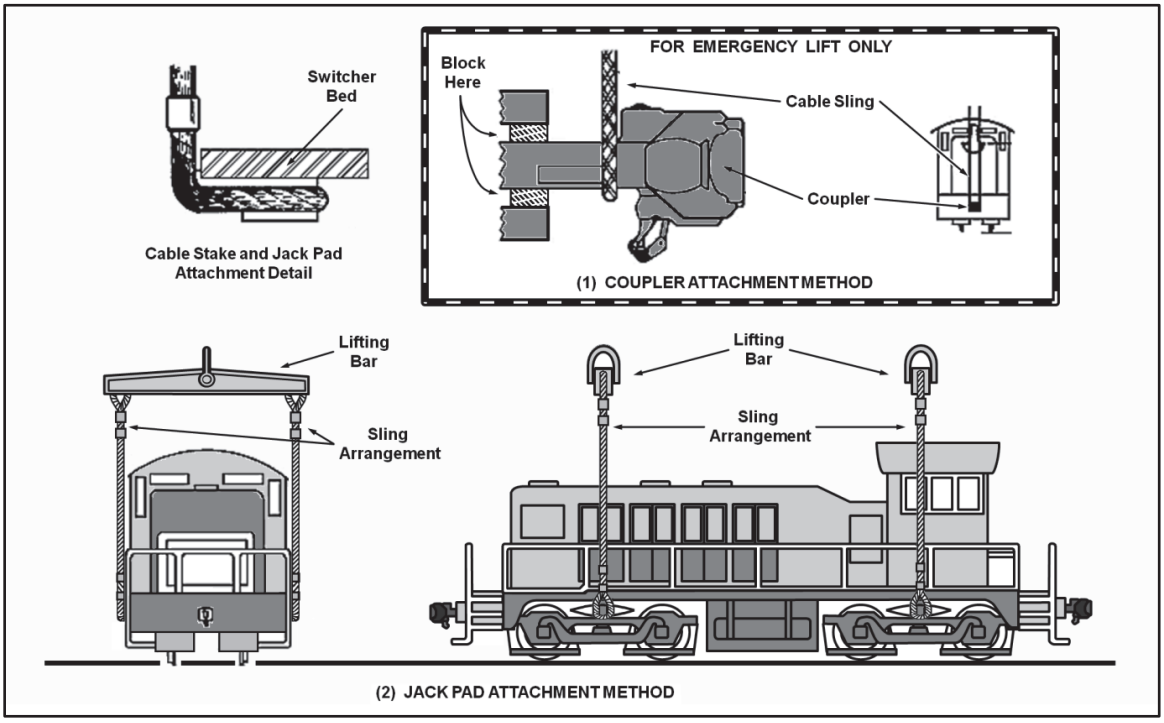


Figure G-47. Methods of lifting electro-motive division road switcher locomotive

Simple Derailment

G-86. Use the following procedure in simple derailments involving only one truck and when the locomotive is upright:

- Rerail locomotive by using rerailers if available and when practicable.
- Use spreader bar and two wire rope slings of adequate strength if available.

- Use two slings if the locomotive is equipped with lifting lugs. No lifting beam is necessary.
- Use sling and coupler hitch on locomotives equipped with a standard coupler locomotive if locomotive is not equipped with lifting lugs, or if the lift cannot be made from one side, or if the wreck crane cannot reach the bolsters. The coupler must be blocked as shown in figure G-47. If it can be avoided, never use a coupler hitch on any locomotive equipped with a retractable coupler.

Truck Removal

G-87. Electro-motive division locomotive frames are strong enough to permit lifting operations with the trucks attached as long as one end is supported at the bolster. However, truck removal may be required under certain wreck conditions. Electro-motive division freight and switcher locomotives use two 4- wheel or two 6-wheel pedestal-type trucks. As preliminary steps, these trucks may be removed from the locomotive by disconnecting brakes, sander hoses, airlines, and traction motor leads. Depending on the locomotive type, the 4-wheel trucks are disconnected by removing three to five holding bolts. Removing these bolts frees the truck locks from the body bolster and side bearings. Free 3-wheel trucks, such as those on the electro-motive division-military railway switcher, by removing the two nuts and bolts that secure each side-bearing clip and then removing the clips. Locomotive frames must be raised a minimum of 6 inches for sideways removal and 27 inches for endways removal.

AMERICAN LOCOMOTIVE-GENERAL ELECTRIC DIESEL-ELECTRIC LOCOMOTIVES

G-88. The frames of American Locomotive-General Electric (ALCO-GE) diesel-electric locomotives, even though specially braced, are designed to be lifted at the bolsters. Lifts closer to the ends of passenger locomotives may cause excessive stresses if the trucks are attached at the time of lift. Road switcher locomotives with trucks attached can normally be lifted at designated lifting points (figure G-48). Lifting eyes are designed only for vertical lifts. When necessary to drag or roll the locomotive, the sling should be attached at the center of the truck.

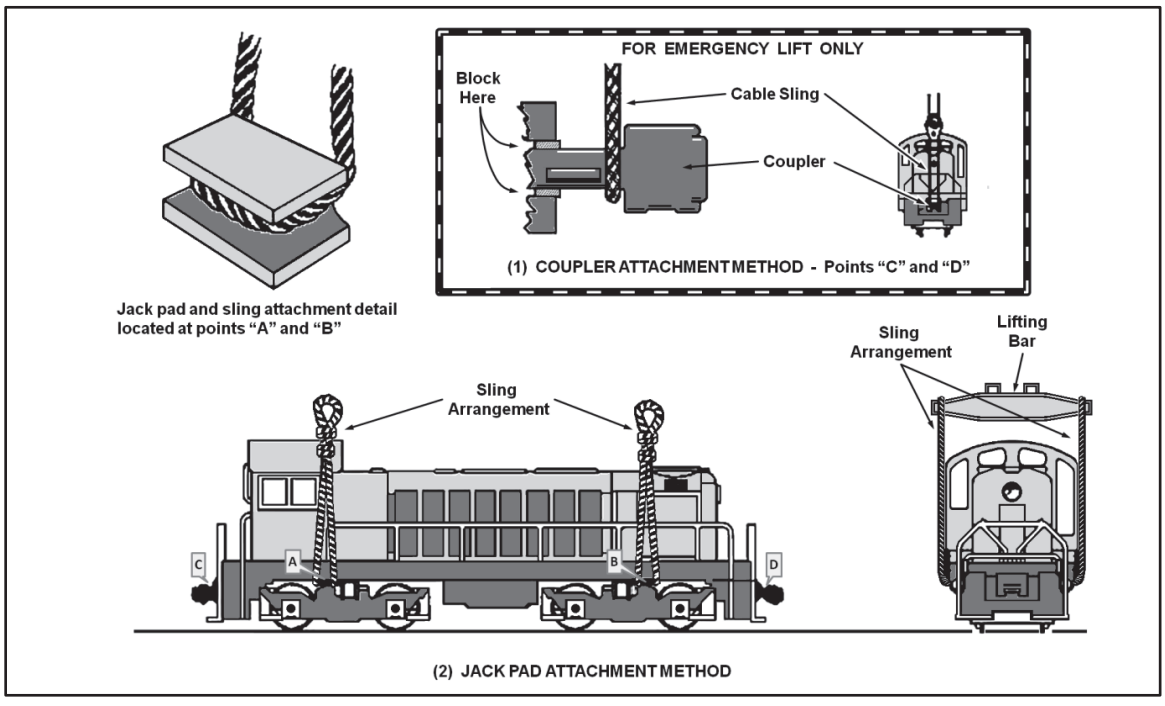


Figure G-48. Jack pad and lifting lugs, American Locomotive – General Electric locomotive

Truck Centerplates

G-89. When lifting only one end of an ALCO-GE locomotive, the same precautions must be taken as when lifting the electro-motive division locomotive.

Lifting Lugs

G-90. ALCO-GE road switchers are equipped with combination jacking pads and lifting lugs attached to the frame on the body bolster (figure G-48 on page G-41). Methods of attaching cable slings for lifting are also shown. If no other hitch is available, the coupler hitch could be used as an emergency lift for all classes of ALCO-GE locomotives.

Simple Derailment

G-91. The recommended lifts, when one or both trucks are derailed and the locomotive is upright and close to the rail, are shown in figure G-48 on page G-41. Slings, rather than rerailing devices (irons), are used to lift ALCO-GE locomotives. The gear case or the gear of the driving axles could crack when using rerailing devices. Do not use the coupler for lifting because of the danger of springing the coupler and, more importantly, seriously springing the frame and buckling the cab. Another disadvantage of the coupler lift is the extreme care required in preventing damage to the centerplates on the end of the truck that is not being lifted. When a coupler lift must be used, the truck on the lifted end should be disconnected. The coupler should be blocked and the sling placed as close to the body as possible.

CAUTION

Under no circumstances should coupler lift be attempted on both ends at the same time. Not only will the frame be sprung, but it is also very likely that the locomotive will roll over.

Truck Removal

G-92. With the exception of certain extreme lifts, the frames of ALCO-GE road switchers are strong enough to permit rerailing without removing the trucks. Truck removal may be necessary under certain conditions because of limited crane capacity or to lighten the weight of the lift. ALCO-GE locomotives include both 4-wheel and 6-wheel trucks. In either case, traction motor leads, air lines, sander pipes, brake rods, and any truck safety chains must be disconnected. The 4- wheel trucks are disconnected from the locomotive frame by removing the four bolts used to hold the truck locks in place. Removing these bolts allows the lock to disengage from the side bearings. ALCO-GE passenger locomotives are equipped with 6-wheel trucks. Truck locks on 6-wheel trucks are held in place by a bolt, which passes through the lock and engages three locking lugs on the body bolster. Removing the two bolts allows the locks to swing free. The ALCO- GE-MRS-type, 1,600-HP, multi-gauge, road switcher, 6-wheel truck does not have these locks. Disconnecting the service appliances and safety hooks frees the truck from the frame.

INSPECTION AFTER RERAILING

G-93. Inspect the diesel-electric locomotive or car trucks after they are rerailed before lowering the locomotive or car body onto the truck. Perform the following when inspecting the locomotive or car truck:

- Raise journal box lids.
- Ensure that wedge and brass are in place.
- Ensure that truck springs are aligned.
- Examine journal lubricator or packing.
- Add any needed oil, then close box.
- Inspect brake rigging and bolster for loose or dragging parts.

TRACK RESTORATION

G-94. The report of a wreck or derailment should include an estimate of how much track is torn up (in rail lengths) and the extent of the damage. Repair crews, tools, and equipment can be transported to the site by the wreck train. Repair crews can begin to remove debris, any spilled car lading, and damaged crossties and rails as soon as the wreck cranes clear away damaged equipment. Ballast is raked, leveled, and replaced as necessary for a firm roadbed. New ties and new rails are laid, connected, gauged, and spiked. To expedite the start of traffic, spiking may be temporarily limited to every other tie plate, and only two bolts, hastily tightened, placed in angle bars. Moving trains over such hastily repaired sections is controlled by slow orders issued by the train dispatcher. Surfacing and lining is also limited initially to the minimum standards required for safely moving trains at slow speeds. Complete ballasting, bolting, lining, spiking, and surfacing can be done after the congestion has been cleared, the wrecked equipment removed, and the line opened.

RESTORING COMMUNICATIONS

G-95. Derailed cars can break off or knock down telephone poles. This can cut wire communications. It may be necessary during recovery operations to cut these lines or remove poles to permit wreck crane booms necessary clearance. In such cases, priority must be given to repairing the circuits as soon as possible to enable the train dispatcher to communicate with the rail line.

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Appendix H

Construction and Rehabilitation Requirements

As stated in chapter 2, the use of existing tracks and facilities as much as possible is the goal. Damaged track can be rehabilitated if possible, but new track construction should be avoided, or may be impossible because of the manpower required. However, when new construction would take less time and manpower than rehabilitation, it may be advisable to construct new track and facilities. Panel track (pre-assembled track panels used to simplify railroad construction) may be used for quick repairs and new construction in the theater. The following are those facilities that may require rehabilitation or new construction.

PRIORITIES

H-1. Trade-offs are made between repairing a railway to full operating capacity while neglecting others, and repairing multiple segments of lines to reduced capacity. It is almost always more important to rehabilitate a rail line so it can operate at a reduced capacity (no signals, primitive operations, and so forth) than to hold all operations until the final spike is driven. In almost every case, trains will be operating while railroad rehabilitation and construction is taking place. Many times operations will continue over the very same track being repaired.

MAIN LINES, YARDS, AND SIDINGS

H-2. When new construction is required, plans for the location and layout of tracks should consider current and future requirements. For rehabilitation, the general track surface must be good enough to meet immediate requirements. Track improvement is undertaken only as necessary to meet minimum requirements for safe operation.

SERVICE FACILITIES

H-3. Adequate service facilities (for example fuel, sand, and water servicing facilities) are of vital importance in railway operations. Normally, railway cars spend over half of their useful life in terminals. If proper facilities do not exist or are not fully used, congestion can occur.

CONSTRUCTION AND REHABILITATION REQUIREMENTS

H-4. Table H-1 lists the materials and net man-hours required for new construction of one mile of standard-gauge, single-track railroad. Table H-2 on page H-2 estimates the requirements for rehabilitating a 100-mile standard-gauge, single-track division extending inland from a port using average percentage of demolition over the entire division.

Table H-1. Construction requirements per mile standard-gauge single-track railroad

ITEM	*STONs*	*MTONs*	*MAN-HOURS*
Grading (includes clearing average wooded terrain)	-	-	5,000
Ballast delivered (average haul: 5 miles; 8.05 km)	-	-	2,500
Tracklaying and surfacing	-	-	3,400
Bridging (70 linear feet; 21.34 m)	128	111	3,200
Culverts (7 per mile; 280 feet; 85.34 m)	8	7	1,400

Table H-1. Construction requirements per mile standard-gauge single-track railroad-*(continued)*

ITEM	*STONs*	*MTONs*	*MAN-HOURS*
Ties (2,900)	218	300	-
Rail, 90-pound—ARA—A Section	79	45	-
115-pound—ARA—E Section	103	57	-
Fastening (based on 39-foot rail) (11.89 meters)	33	10	-
Total	569	530	15,500

Legend:
ARA = American Railway Association
STON = short ton
MTON = metric ton

Table H-2. Rehabilitation requirements per railroad division

Item	*Per 100 Miles (161 km)*	*Percent of Demolition*	*Rehabilitation (quantity)*	*Construc-tion STONs*	*Material MTONs*	*Man-Hours [1] (Thousands)*
Main line trackage	100 mi	10	7.0 mi	2,708	1,033	36.4
Port trackage [2]	-	100	3.0 mi	1,368	1,092	14.4
Passing sidings [2]	2.4 mi	80	2.4 mi	1,049	874	11.5
Station sidings [2]	1.6 mi	80	1.6 mi	730	582	7.7
Railway terminal [2,3]	1.0 ea	75	0.75 ea	8,025	4,875	160.0
Water stations	3.0 ea	100	3.00 ea	135	210	9.0
Fuel stations	1.0 ea	100	1.00 ea	19	16	0.9
Bridging (70 ft per mile)	7,000	55	2,700 linear ft	2,700	2,672	70.0
Culverts	28,000 linear ft	15	4,200 linear ft (74 ea)	63	63	13.7
Grading and ballast	-	-	-	-	-	40.5

Legend:
ea = each
ft = feet
km = kilometer
mi = mile
MTON = metric ton
STON = short ton

[1] – Tunnels require special consideration. To repair (by timbering) a 50-foot demolition at each end of a single track tunnel (100 ft total per tunnel), allow 70 STONs or 87 MTs, and 3,000 man-hours.
[2] – Estimate includes ties, rails, fastenings, turnouts, track laying, and surfacing. It is assumed ballasts is available at work sites.
[3] – Includes replacing buildings 100 percent, ties 30 percent, rail and turnouts 85 percent.

Appendix I
Railroad Assessment

As part of the expeditionary railway center's primary mission set, capability assessment, assigned personnel must be proficient in conducting railroad assessments of varying scale across the levels of war. A complete understanding of the operational environment's rail capacity can assist sustainment planners in providing commanders with freedom of action, operational reach, and prolonged endurance. This appendix provides RPATs, RATs, RACs, and other assessment teams with assessment formats and considerations to provide better situational understanding.

I-1. Railroad assessments and knowledge products are the ERC personnel's contribution to a supported unit's military decision-making process. During the assessment, RATs and RACs will collect data, analyze information, and develop knowledge to assist commanders and staffs in building the understanding needed to inform their decisions. In the context of decision making, *knowledge* is information that has been analyzed and evaluated for operational implications (ADP 6-0). Figure I-1 depicts the process to achieve understanding. For more information on achieving understanding see ADP 6-0.

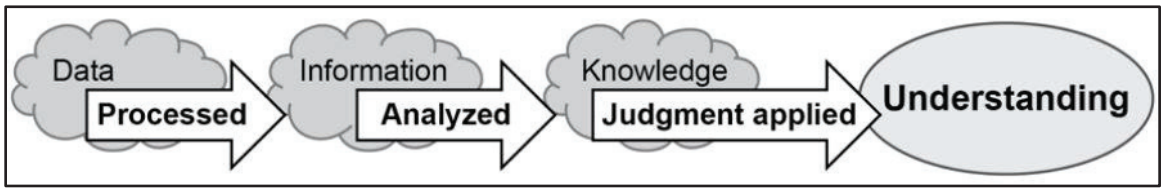


Figure I-1. Achieving Understanding

RAILROAD DATA COLLECTION AND ASSESSMENTS

I-2. In the context of decision making, *data* consists of unprocessed observations detected by a collector of any kind (ADP 6-0). Railroad assessments begin with data collection. It is here that RATs and RACs gather observations about a given railroad, through both digital and physical reconnaissance, to begin building a full understanding of the railroad's capabilities and capacity.

I-3. While rail assessments are primarily data collection. ERC personnel will simultaneously conduct assessments to determine the quality and grade of the rail structure. This section discusses a few of the tools ERC personnel use to organize the collected data and assessments.

RAILROAD TRACK OR BRIDGE ASSESSMENT

I-4. Most comprehensive railway assessments begin with the railroad track or bridge assessment. The intent of this assessment is to determine the type and quality of the railroad and associated infrastructure in a given area. It is applicable to domestic and foreign railways regardless of ownership. This assessment can be used to feed port, railyard, and installation rail assessments or as a standalone product. See chapter 4 for more detail on railway structure and quality assessment. Railroad track or bridge assessments should include but are not limited to-

- Rail type, gauge, and weight.
- Track type(s).
- Switch type(s).
- Tie type(s).

- Maximum grade.
- Maximum car load weight.
- Track speed(s).
- Signaling.
- Other infrastructure associated with the railroad.
- A quality assessment of the railroad.

I-5. Figure I-2 provides an example format for a railroad track or bridge assessment to be used in combination with chapter 4 of this publication, ERC standard operating procedures, and HN standards as applicable.

RAILROAD TRACK / BRIDGE ASSESSMENT							
IDENTIFICATION							
DATE OF ASSESMENT:					ASSESMENT POC:		
TRACK ID: #3		GRID LOCATION: 64368800 SW TO 64369000 NW					
LOCATION IN OVERALL DIAGRAM FROM PG 1: (Example: Bottom left Quadrant)							
TRACK OR BRIDGE TYPE: Main, yard, siding, transfer, spur, open ballast deck, wood truss, steel girder							
TRACK DATA							
TRACK LENGTH: 800 ft					# OF SWITCHES: 8		
RAIL TYPE: ribbon (welded), 90 ft stick					SWITCH TYPE: manual, spring		
RAIL GAUGE: 56.5 in					TIE TYPE: concrete, wood, composite		
RAIL WEIGHT: 80 lb.					FASTENER TYPE: hinge bracket, spike		
MIN. SIDE CLEARANCE: 42 in					PLATE TYPE: flat, canted, etc.		
MIN. Ht CLEARANCE: 18 feet					MAX GRADE: 0.15%		
MIN. CURVATURE: 100 ft					# OF BRIDGES: 1		
MAX CAR Load Wt: 80 Tons					BRIDGE TYPE: ballast, wood truss, steel		
TRACK SPEED: 20 MPH					CULVERTS: steel, concrete		
TERMINUS: butt block, wheel stops, dock					SIGNALS: Block, automatic, CTC		
TRACK CONDITION							
TRACK:	Ideal	Good	Sufficient	X	Poor	Derelict	(FRA Excepted)
DESCRIPTION:	Track is in overall FRA class one condition. Would recommend speeds 5-10 MPH.						
CLASS: 1,2,3,etc.							
TIES:	Ideal	Good	Sufficient		Poor X	Derelict	
DESCRIPTION:	About every 5th tie sufficient. All others are either poor or derelict and should be replaced before bringing cars over 120 gross tons over track.						
SWITCHES:	Ideal X	Good	Sufficient		Poor	Derelict	
DESCRIPTION:	#10 switch at entrance to track. Recently replaced and is in ideal condition.						
DRAINAGE:	Ideal	Good	Sufficient	X	Poor	Derelict	
BALLAST TYPE:	crushed stone				BALLAST SIZE: 7"		
DESCRIPTION:	Concreate culverts are located every 50'. North 200' of culverts need to be cleared of debris						
VEGETATION:	SPRAY CONTROL: Yearly				TREE / OVERHANG CLEARANCE: close		
DESCRIPTION:	Tracks are sprayed in the spring and fall. Trees are overhanding north side of tracks and scraping rolling stock						
TRANSFER ASSETS:	NUMBER:	2			TYPE:	over head crane	
	CAPACITY:	100 ton			RATE:		
	CONDITION:	good condition, 5 years old					
SAFETY:	SIGNAGE:	Close clearance south side of track due to dock					
	LIGHTING:	photo cell activated over head lights. Track is well lit.					
	OTHER:						
SECURITY:	ASSETS:	fencing, cameras					
	RESPONSIBILITY:	Ministry of Commerce Border Police, DoD guards, contractor					
	RATING:	Sufficient, excellent					
CROSSINGS:	#:	3			TYPE:	pedestrian, active, passive, paved, dirt	
	CONDITION:	poor due to drainage					
STRUCTURES:	TYPE:	inspection platform, fuel point, scanner, transfer house, locomotive shop, etc.					
	CONDITION:	good, poor, 5 years old, etc.					

SAMPLE

Figure I-2. Example Railroad Track or Bridge Assessment

RAILROAD YARD OR RAILHEAD ASSESSMENT

I-6. The intent of the railroad yard or railhead assessment is to collect data about the structure, organization, and operation of a specific rail activity. It is applicable to both foreign and domestic railroad yards or railheads regardless of ownership. The assessment is used to develop rail knowledge and understanding. This assessment begins to answer questions regarding railroad facilities and capabilities. Railroad yard or railhead assessments should include but are not limited to—

- Identifying information of the railroad yard or railhead.
- Number and types of tracks.
- Number and types of switches.
- Information about other rail structure.
- Track speeds.
- Cargo limitations.
- Ramp types and weights.
- Materiel handling equipment types and weights.
- Operational controls and methods.
- Main line location (when applicable).
- Information about access and amenities.

I-7. Figure I-3 provides an example format for a railroad yard or railhead assessment to be used in combination with chapter 4 of this publication, ERC standard operating procedures, and HN standards as applicable.

RAILROAD YARD / RAILHEAD ASSESSMENT	
DATE OF ASSESMENT:	**ASSESMENT POC:**
YARD NAME: Main classification yard	
LOCATION:	
TYPE OF YARD / RAILHEAD: storage, classification, bunker, vehicle loading, container loading	
TOTAL # OF TRACKS: 13	**TOTAL # OF SWITCHES:** 14
SWITCH TYPE(S): spring, ridged, etc.	**SWITCH SIZE (RADIUS #):** Main line #10 / Yard #8
TOTAL # OF CROSSOVERS: 2	**WEIGHT(S) OF RAIL:** 130 lb. in curves, all other 80 lb.
TYPES OF RAIL TIE(S) USED: Wood, composite	**OVERALL CONDITION OF TIES:** Fair
TYPES OF RAIL SPIKES OR FASTENERS USED: Nail Spikes, Screw spikes, fastener latch spikes for concrete	
TYPES OF RAIL PLATES USED: Flat, canted, double sided, single sided	
SPEED LIMIT: 10 MPH	**SPEED RESTICTIONS:** 5 MPH through switches
CARGO WEIGHT LIMIT: 100 tons per railcar	**HIGHWAY GRADE CROSSING(S):** 8
RAMP TYPE(S): 3 concrete end ramp, 1 mobile ramp	**RAMP WEIGHT LIMIT:** 80 Tons
CRANE TYPE(S): 3 TREX, 3 Forklifts	**CRANE WEIGHT LIMIT:** 20 Tons
ARE THERE MOUNTED LIGHTS? Yes	**ARE LIGHTS AUTOMATIC OR MANUAL:** Manual
WHO CONTROLS OPERATIONS IN THIS YARD?: (Example: "The rail operations manager is the yardmaster and coordinates with operations division to determine when and where railcars are to be moved.")	
IS THERE A TIMETABLE? Yes	**RULE SYSTEM USED:** Example: GCOR, NORAC, CSX
METHOD OF OPERATION: Yard Limits, Other than main, CTC, Track Warrant	
HOW ARE RAIL CARS SECURED? 2 hand brakes south end per track and 1 wheel chalk	
METHOD RAIL CARS ARE TRACKED: Excel spread sheet with track inventory maintained by Yard Master	
ARE THERE ANY MAIN LINES? (Example: There are two main lines that run parallel to this yard and both are located on the North-West side of the yard. The yard connects to the main line from the north.)	
WHEELED VEHICLE ROAD ACCESS? No roads currently run through this Yard but there is road access to the edge from the Southern side as well as the North. (See schematic below & map for details)	
BRIEFLY DESCRIBE THE YARD AMENITIES: Track 5 is designated as a repair track. It can also double as a container loading track if operation overflow is required. Three ramps are located at this yard on track 1, 2 and 3.	
PHYSICAL SECURITY: Yard is patrolled by local DoD guard force. South end is secured by locked gate. Keys can be obtained by Rail Operations Supervisor or local MP office. Gate must be manned at all times when open.	
ADDITIONAL COMMENTS AND YARD DIAGRAM:	

SAMPLE

Figure I-3. Example Railroad Yard or Railhead Assessment

PORT (RAIL) ASSESSMENT

I-8. The intent of the port (rail) assessment is to collect data about the structure, organization, and operation of a port and associated rail infrastructure. It is applicable to both foreign and domestic ports regardless of ownership. The assessment is used to develop rail knowledge and understanding. This assessment begins to answer questions regarding port adjacent rail facilities and capabilities. Port (rail) assessments should include but are not limited to—

- Identifying information of the port.
- Port points of contact.
- General arrangement of rail facilities at the port.
- Number of rail personnel and operating crews.
- Number of locomotives and non-interchange cars.
- Activity responsibly for rolling stock maintenance.
- Activity responsible for track maintenance.
- Track speeds.
- Wharf, dock, and ramp information.
- General track and railroad yard information and assessments.
- Materiel handling equipment types and weights.
- Operational controls and methods.
- Main line location (when applicable).
- Information about access and amenities.
- Information about other rail structure.

I-9. Figure I-4 provides an example format for a port (rail) assessment to be used in combination with chapter 4 of this publication, ERC standard operating procedures, and HN standards as applicable.

PORT (RAIL) ASSESSMENT					
DATE OF ASSESMENT:	ASSESMENT POC:				
PORT NAME: Military Ocean Terminal Sunny Point (MOTSU)					
PORT OFFICE ADDRESS:					
PHONE #:	ALTERNATE PHONE:				
CELL #:	ALTERNATE PHONE CELL:				
POC:	ALTERNATE POC:				
TOTAL SQ ACR OF PORT: 8,550	FRUSTRATED CARGO AREA:				
# OF RAIL PERSONNEL: 12	# OF RAIL OPERATING CREWS: 2 Yard masters				
# OF LOCOMOTIVES:	# OF NON-INTERCHANGE RAIL CARS:				
ROLLING STOCK MAINT.: Contractor	TRACK MAINT.: Contractor				
SPEED LIMIT: 10 on straight, 5 in swtches	SPEED RESTICTIONS:				
	MINIMUM RADIUS CURVE:				
DOCK TYPE: Hard stand, RORO, side load, concrete, wood	RAMPS: (FIXED OR PORTABLE)				
# of WHARFS: 3 = North, Center and South	# OF BIRTHS: 9, 3 on each wharf				
WHARF WEIGHT LIMIT	BIRTH LENGTH:				
#1	#1	#2	#3	#4	#5
#2	#1	#2	#3	#4	#5
#3	#1	#2	#3	#4	#5
#4	#1	#2	#3	#4	#5
LIGHTS:	CRANE TYPE:				
CRANE CAPACITY:					
RAIL CAR CARGO WEIGHT LIMIT:	HIGHWAY GRADE CROSSING(S):				
TOTAL # OF YARDS:	TOTAL # OF TRACKS:				
WEIGHT(S) OF RAIL:	OVERALL CONDITION OF RAIL:				
TOTAL # OF SWITCHES:	TYPE(S):				
TYPES OF RAIL TIE(S) USED:	OVERALL CONDITION OF TIES:				
SECURITY:					
TYPES OF RAIL SPIKES OR FASTENERS USED:					
TYPES OF RAIL PLATES USED:					
WHO DISPATCHES / CONTROLS TRAIN OR RAIL MOVEMENTS?					
IS THERE A TIMETABLE?	RULE SYSTEM USED:				
METHOD OF OPERATION:					
METHOD RAIL CARS ARE TRACKED:					
MAIN LINE LOCATIONS:					
BRIEFLY DESCRIBE THE PORT AMENITIES:					
ADDITIONAL COMMENTS:					

SAMPLE

Figure I-4. Example Port (Rail) Assessment

INSTALLATION RAILROAD ASSESSMENT

I-10. The intent of the installation railroad assessment is to survey the rail capability and capacity of military activities. It is applicable to any activity from expeditionary railheads to CONUS basing. The installation railroad assessment draws from the above assessments when applicable. The installation railroad assessment expands on this with broader consideration of rail infrastructure, operating personnel, and equipment. Additionally, this assessment should consider—

- The number and duties of railroad personnel.
- The number of rail crews.
- The number and type of locomotives.
- The number and type of non-interchange cars.
- Dispatch and movement control procedures and documents.
- Rule system(s) in effect.
- The general array of rail lines on the installation.
- Type(s) and location(s) of rail yard(s).
- Amenities that improve rail operations, cargo operations, and quality of life.

I-11. Figure I-5 provides a format for an installation railroad assessment to be used in combination with chapter 4 of this publication, ERC standard operating procedures, and HN standards as applicable.

INSTALLATION RAILROAD ASSESSMENT	
DATE OF ASSESMENT:	**ASSESMENT POC:**
INSTALLATION NAME: Ft Minute Man	
RAIL OFFICE ADDRESS:	
PHONE #:	**ALTERNATE PHONE:**
CELL #:	**ALTERNATE PHONE CELL:**
POC:	**ALTERNATE POC:**
# OF PERSONNEL: 12 PAX = 6 crew + 6 MOW	**# OF RAIL CREWS:** 2 crews, 3 PAX each
# OF LOCOMOTIVES: 2 GENSET, 3 GP-10	**# OF NON-INTERCHANGE RAIL CARS:** 15 USAX box
ROLLING STOCK MAINT.: DoD civ for Army eqp Locomotives maintained by contractor	**TRACK MAINT.:** **Contractor**
SPEED LIMIT: 10 MPH	**SPEED RESTICTIONS:** **5 MPH through switches**
RULING GRADE: 1.2%	**MINIMUM RADIUS CURVE:** **100 ft**
CARGO WEIGHT LIMIT: 100 tons per railcar	**HIGHWAY GRADE CROSSING(S):** 8
TOTAL # OF YARDS: 6	**TOTAL # OF TRACKS:** 67
WEIGHT(S) OF RAIL: 80-130 lb. Rail	**OVERALL CONDITION OF RAIL:** (REFERENCE) GOOD
TOTAL # OF SWITCHES: 164	**TYPE(S):** MANUAL, AUTOMATIC, RCO Operated: All 3
TYPES OF RAIL TIE(S) USED: Wood	**OVERALL CONDITION OF TIES:** (REFERENCE) FAIR
TYPES OF RAIL SPIKES OR FASTENERS USED: (Nail Spikes, Screw spikes, fastener latch spikes for concrete)	
TYPES OF RAIL PLATES USED: (Example: Flat, canted, double sided, single sided)	
WHO DISPATCHES / CONTROLS TRAIN OR RAIL MOVEMENTS? (Example: "The rail operations manager controls train movements on and off post and works for the operations division S-3.")	
IS THERE A TIMETABLE? Yes	**RULE SYSTEM USED:** Example: GCOR, NORAC, CSX
METHOD OF OPERATION: Example: Yard Limits, Other than main, CTC, Track Warrant	
METHOD RAIL CARS ARE TRACKED: Example: Excel speed sheet with track inventory maintained by Yard Master	
WHERE ARE THE MAIN LINES? (Example: There are 4 main lines that run through RM Terminal. 2 of the main lines run in a N-S direction outside of Yard Limits. A third main line runs just north of the terminal originating from the N-S main line and running North West towards the town of Wilson. A 4th main line also runs just north of the terminal and also originates from the N-S main line running North-East and connecting to the "Connors" Sub Division.)	
TYPES OF RAIL YARD: (EXAMPLE: RAIL HEAD {Ramp}, STORAGE YARD, CLASSIFICATION etc.) "There are 5 Yards within Rocky Mount Terminal = A Receiving Yard, a switching yard, a fuel yard, a shop yard, and a departure yard"	
BRIEFLY DESCRIBE THE YARD AMENITIES: (Example: "RM has water, sand, and fuel locations, a crew house, a yardmaster tower, 4 concrete loading ramps for rail, remote control switches, remote control switches via RCO, RTCH & Crane unloading facilities (See Track number s 1 through 10 on the following pages.) It does store HAZMAT cars of all types. It services 23 companies locally. It's main yard is organized into 4 divisions each controlled by an RCO.)	
ADDITIONAL COMMENTS: There is a staging area roughly 1/2 mile by 1/4 mile located just East of Zone 90 where at least 100 trucks towing 60 foot trailers can stage their equipment for RORO. The area is all concrete and can support vehicles of all types. Rail to Air lift and vice versa also possible on spur tracks. (See attached) There are also several nearby spur tracks and sidings which are accessible from main roads and could be used to support refueling points for tracked and wheeled vehicles.	

SAMPLE

Figure I-5. Example Installation Railroad Assessment

RAIL INFORMATION PROCESSING

I-12. In the context of decision making, *information* is data that has been organized and processed in order to provide context for further analysis (ADP 6-0). After conducting rail assessments, the RAT or RAC combines and organizes the collected data from the rail assessments in order to answer requests for information from the supported unit. This is typically organized in to a brief which supports staff and commanders in the military decision-making process through improved understanding.

I-13. From the assessments, rail assessment teams should begin to answer questions that apply to an operational environment as a whole:

- How many rail crews are available to conduct concurrent operations?
- How many locomotives are mission ready and how much can they move?
- How many cars can be stored at certain rail yards?
- Which units can use a certain railhead?
- Can a particular railhead load or off-load armored vehicles?
- How many miles of track are operational and where are possible choke points?
- What is the command and operations structure look like throughout an operational area?
- How many trains can be moved, loaded, and unloaded in a 24-hour period?

RAIL INTELLIGENCE PRODUCTS

I-14. *Intelligence* is the product resulting from collection, processing, integration, evaluation, analysis and interpretation of available information concerning foreign nations, hostile or potentially hostile forces or elements, or areas of actual or potential operations (JP 2-0). Rail assessment teams' primary intelligence product for commanders and staffs is the installation or activity rail continuity book.

INSTALLATION OR ACTIVITY RAIL CONTINUITY BOOK

I-15. The installation or activity rail continuity book provides commanders and staffs with a standard method to collect and store rail capability and capacity data. It organizes information by subject, provides a central storage point for reference, serves as a knowledge base to support the military decision-making process, and provides continuity for follow-on units. The installation or activity rail continuity book, in combination with rail specific briefs tailored to the supported unit, answers strategic level questions such as:

- Can a specific railhead support an ABCT deployment and over what time frame?
- How many cars can a specific railhead and supporting personnel load in 24 hours?
- How long will it take from start of loading to complete deployment for a given unit?

I-16. To achieve the above purposes, the installation or activity rail continuity book should include but is not limited to—

- Installation or activity rail specific history.
- Overall capability and capacity quick reference.
- Task organization of rail operations.
- Rail movement and operations processes.
- Railroad track or bridge assessments.
- Railroad yard or railhead assessments.
- Port (rail) assessments (as applicable).
- Installation railroad assessments.
- Supporting rail imagery (when available).
- Rail equipment available by type.
- Maintenance capability.
- Recommendations for rail improvement by the assessment team.
- Contact information of assessment team and key personnel in the rail operations process.
- Terminology defined in ways for non-rail personnel to understand.

Glossary

SECTION I – ACRONYMS AND ABBREVIATIONS

ADP	Army doctrinal publication
ALCO-GE	American Locomotive-General Electric
AR	Army regulation
ATP	Army techniques publication
CBRN	chemical, biological, radiological, or nuclear
COIN	counterinsurgency
CR	curve resistence
CTC	centralized traffic control
CTE	continuous tractive effort
DA	Department of the Army
DA Pam	Department of the Army pamphlet
DOD	Department of Defense
DBP	drawbar pull
EDT	end delivery tonnage
ERC	expeditionary railway center
ESC	expeditionary sustainment command
FM	field manual
GR	grade resistence
GTL	gross trailing load
HN	host nation
HQ	headquarters
JP	joint publication
LD	length of division
MPH	miles per hour
NATO	North Atlantic Treaty Organization
NCOIC	noncommissioned officer in charge
NDT	net division tonnage
NTL	net trainload
OIC	officer in charge
RAC	rail advisory crew
RAT	railway advisory team
RPAT	railway planning and advisory team
RR	rolling resistence
S	average speed
STE	starting tractive effort

STON	short ton
TAT	turn-around time
TD	train density
TSC	theater sustainment command
UMC	unit movement coordinator
UMO	unit movement officer
U.S.	United States
WF	weather factor

SECTION II – TERMS

***chief train dispatcher**

Supervises train movement, reroutes rail traffic in emergencies, determines train tonnage, orders motive power, determines rail line capacity, and establishes train movement priority.

***combination yard**

Yard that is a combination of receiving, classifying, and departure facilities.

***continuous tractive effort**

The effort required to keep a train rolling after it has started. Also referred to as CTE.

counterinsurgency

Comprehensive civilian and military efforts designed to simultaneously defeat and contain insurgency and address its root causes. (JP 3-24)

***curve resistance**

The resistance offered by a curve to the progress of a train. Also referred to as CR.

data

In the context of decision making, unprocessed observations detected by a collector of any kind (human, mechanical, or electronic). (ADP 6-0)

***deck**

The surface of a railcar on which a load rests.

***departure yard**

Yard where classified cars are made up into trains.

***derailer**

Safety devices designed to limit unauthorized movement of a car or locomotive beyond a specific point.

***drawbar pull**

The actual pulling ability of a locomotive after deducting from tractive effort, the energy required to move the locomotive itself. Also referred to as DBP.

***end delivery tonnage**

The through tonnage, in short tons, of payload that is delivered at the end of the railway line (railhead) each day. Also referred to as EDT.

***grade resistance**

The resistance offered by a grade to the progress of a train. Also referred to as GR.

***gross trailing load**

The maximum tonnage that a locomotive can move under given conditions. Also referred to as GTL.

***guard rail**

A rail or series of rails that lay parallel to the running rails of a track that help prevent derailments by holding wheels in alignment and keeping derailed wheels on the ties.

information

In the context of decision making, data that has been organized and processed in order to provide context for further analysis. (ADP 6-0)

intelligence

Intelligence is the product resulting from the collection, processing, integration, evaluation, analysis, and interpretation of available information concerning foreign nations, hostile or potentially hostile forces or elements, or areas of actual or potential operations. (JP 2-0)

insurgency

The organized use of subversion and violence to seize, nullify, or challenge political control of a region. Insurgency can also refer to the group itself. (JP 3-24)

knowledge

In the context of decision making, information that has been analyzed and evaluated for operational implications. (ADP 6-0)

***main track**

Track that extends through yards and between stations.

***net division tonnage**

The tonnage in short tons, or payload, which can be moved over a railway division each day. Also called NDT.

***net trainload**

The payload carried by a train. Also referred to as NTL.

***progressive yard**

A multifunctional yard structured to move cars in a fluid and rapid manner, containing receiving, classification, and departure yards.

***receiving yard**

Yard where trains are cleared promptly on arrival to prevent main line congestion.

***rerailer**

Cast iron devices used in simple derailments to retrack cars and locomotives.

***rolling resistance**

The force components acting on a train in a direction parallel with the track, which tend to hold or retard the train’s movement. Also referred to as RR.

***running track**

Tracks that extend the entire length of the yard and provide a route of travel to any point in the yard independent of the switching leads and classification tracks.

***safety factor**

The ratio of the strength of the rope to the working load.

***starting tractive effort**

The power exerted by a locomotive to move itself and its load from a dead stop. Also referred to as STE.

***subballast**

Gravel, sand, or cinders used to provide a level surface for the ballast and other track components.

***switch engines**

The type of motive power used for receiving cars, classifying, and reassembling them for delivery or forward movement.

***switch stand**

The mechanism which controls the operation of the switch and shows its position.

***switch tie**

Specially cut and formed hardwood crossties, designed to support switches, switch stands, and the moveable rails of a switch.

***track alignment**

The horizontal dimension of a track; for example, curves.

***track profile**

The vertical dimensions of the track caused by terrain features such as hills or valleys.

***tractive effort**

A measure of the potential power of a locomotive expressed in pounds.

***train density**

The number of trains that may be operated safely over a division in each direction during a 24-hour period. Also referred to as TD.

***train dispatcher**

Responsible for main-line movement of passenger and freight trains on a division.

unconventional warfare

Activities conducted to enable a resistance movement or insurgency to coerce, disrupt, or overthrow a government or occupying power by operating through or with an underground, auxiliary, and guerrilla force in a denied area. (JP 3-05)

***underframe**

The structure of a railcar under the deck that supports the weight of the load.

***wreck train**

A train specially configured and tailored to conduct wreck recovery operations.

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