CHAPTER 4
RAIL TRANSPORT

This chapter covers the various aspects and phases of military rail operations as they pertain to CONUS and the overseas theater.

Section I
ORGANIZATION AND OPERATIONS

RAILWAY UNITS

The term "transportation railway service" applies to railway units assigned or attached to a major transportation organization, normally a transportation composite group or a transportation command. The TRS includes supervisory, operating, and maintenance units. These units operate trains, maintain rail lines of communication and trackage, and perform direct support and general support maintenance on locomotives and rolling stock. Depending on the extent of the operation, any TRS supervisory unit may perform staff and planning functions and serve as the highest echelon of military railway service in a theater.

See Appendix A for a listing of railway units according to TOE, mission, assignment, and capability. See FM 55-20 for a detailed discussion of these units.

ADMINISTRATION

Military railway operations are accomplished in three phases. The purpose of these phases is to reduce requirements for military units and personnel, as follows:

• Phase I – Military railway personnel conduct operations exclusively.

• Phase II – Military railway personnel operate and maintain railway lines, augmented and assisted by local civilian railway personnel.

• Phase III – LN civilian railway personnel operate and maintain railway lines. The highest military railway echelon in the theater directs and supervises operations. This arrangement releases unit railway personnel for other duties and begins whenever local conditions permit.

Generally, these phases are conducted in sequence. Sequence may vary, however, depending on military requirements. A phase II or phase III operation may be initiated without progressing through or regressing to previous phases.

For sample SOP formats for rail movements and the transportation railway service, see Figure 4-1, page 4-2, and Figure 4-2, page 4-3.

OPERATIONS PLANNING

A number of factors should be considered when planning the most effective use of a railway system. Among the most important are line length and location and capacity of yards. Others include:

• Roadbed and track condition.
• Track gauge.
• Track type (single, double, or multiple).
• Rail weight.
• Ballast type and depth.
• Tie type (if wood, treated or untreated).

• Tie spacing.

• Axle load limitations (track and bridge).

• Line profile showing location and length of ruling grade.

• Line alignment showing location and length of minimum-radius curves.

• Location and description of bridges and tunnels.

• Location and length of passing tracks.

• Location, type, and quantity of fuel supply.

• Location, quantity, and quality of water supply.

• Location and capacity of car repair shops and enginehouses.

• Type and availability of motive power, i.e., diesel electric, electric, steam (weight in working order, expected working tractive effort, drawbar pull, and age).

• Type and availability of rolling stock (capacity, dimensions, and age).

• Climatic and prevailing weather conditions.

• Diagrams showing minimum structure, maximum unrestricted loading, and equipment gauges.

• Signal system (wire and radio requirements and coordinating responsibilities).

• Dispatching facilities.

• Route junctions.

• Availability of new equipment and repair parts.

• Local labor resources.

Because the direction of military movements is primarily forward, military rail line capacity estimates are usually based on net tonnage moved in one direction. The movement of trains in both directions must also be considered since total capacity is based on train density. When the railway net includes several divisions and branch lines, separate estimates should be made for each. When estimating rail line payload capacity, power (locomotive) and resistance (rolling, curve, and weather) are the limiting factors. The following factors and formulas should be used in the order listed.

(Classification)

STANDING OPERATING PROCEDURE

1. GENERAL. Policies and factors involved in selecting and carrying out railway movements.

2. SUPPLY MOVEMENTS
    a. Releases. Date required, procurement methods, formats, dissemination, action required.
    b. Routing. Responsibilities and procedures.
    c. Diversions and reconsignments. Authority and initiating procedures for method used.
    d. Records and reports. Responsibilities and methods for maintaining specific reports and appropriate references to reports.

3. TROOP MOVEMENTS
    a. Current situation (for example, war, peace, partial or full mobilization, civil unrest).
    b. Distance to be traveled.
    c. Origin and destination points.
    d. Security requirements.
    e. Tactical situation.
    f. Types and amount of equipment available.
    g. Priority.

(Classification)

Figure 4-1. Sample format for rail movements SOP

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(Classification)

STANDING OPERATING PROCEDURE

1. GENERAL
   a. Rail transportation integration in the theater transportation net.
   b. Operational control.
   c. Coordination with adjacent commands for rail use and support of operating units.
   d. Coordination of the theater rail plan for selection, rehabilitation, and operation of rail line to support theater strategic plans.

2. MISSION. Rail net and facilities operated; terminals, installations, and commands supported.

3. ORGANIZATION. Available operating units, location, and operating limits.

4. FUNCTIONS. Responsibilities for operation and maintenance of military railways and equipment, as well as for freight, passenger, and special trains.

5. PLANNING

   a. Long-Range.
      (1) Responsibilities and procedures.
      (2) Primary and alternate rail routes selection.
      (3) Line capacity, troop equipment, and supply requirements.
      (4) Rehabilitation and projected requirement.
      (5) Communication and security requirements.
      (6) Demolition plans.
   b. Short-Range.
      (1) Current operational plans.
      (2) Current rail line capacity and requirements.
      (3) Phases of operation.
      (4) Selection and rehabilitation of new or additional facilities.

6. OPERATIONS

   a. Disseminating and implementing movement programs.
   b. Coordinating with the transportation movements officer.
   c. Setting priorities for rail equipment and its use.
   d. Preparing and compiling operational and situation reports.
   e. Ordering cars and documenting their use.
   f. Scheduling special trains.
   g. Assisting in construction and placing of railcar spanners.
   h. Inspecting loaded cars.

7. MAINTENANCE. Responsibilities, procedures, inspections, reports, and standards for maintaining military and utility railway facilities and equipment.

8. SUPPLY. Responsibilities and procedures for requisitioning, stocking, distributing, maintaining levels of, disposing of excess, and accounting for railway operating and maintenance supplies; requirements and priorities for major items, including locomotives and rolling stock.

Figure 4-2. Sample format for transportation railway service SOP

9. INTELLIGENCE AND RECONNAISSANCE. Responsibilities and procedures for collecting, processing, disseminating, and using intelligence.

10. SECURITY. Procedures, responsibilities, and coordination of security requirements for trains and rail line-of-communication facilities, defense and demolition plans, and supplies en route by rail.

11. RECORDS AND REPORTS. Responsibilities and procedures for records and reports of railway operations, situation, personnel status, equipment maintenance and inspection, equipment status, and projected status.

12. TRAINING. Responsibility for conducting unit and technical training.

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(Classification)

Figure 4-2. Sample format for transportation railway service SOP (continued)

Weight on Drivers

The weight on drivers of a locomotive is that weight supported by the driving (powered) wheels when they rest on a straight and level track. Weight on drivers does not include any of the remaining portion of the locomotive's weight.

Weight on drivers is expressed in STONs. Different types and classes of locomotives differ in weight. All locomotives are constructed to specifications issued by the purchaser, the using railroad, or the manufacturer. See Table 4-1, page 4-5, for the weight on drivers of some common types of diesel-electric locomotives used by the Army. See FM 55-20 for a complete breakdown of Army locomotive characteristics.

Tractive Effort

The horizontal force that a locomotive exerts if the wheels do not slip is known as tractive effort. Expressed in pounds, TE measures a locomotive's potential power. The TE is supplied by the locomotive manufacturer. See FM 55-20 for the TEs of Army locomotives. When data is not available, use the formulas that follow to compute TE. Be sure to allow for locomotive age and condition.

Starting TE is the power that a locomotive has available to move itself and its load from a stopped position. Continuous TE is the effort required to keep a train rolling after it has started. As train momentum increases, needed TE diminishes rapidly. In steam locomotives, there is no difference between starting and continuous TE. A steam locomotive can generally continue to pull what it can start. However, a diesel-electric locomotive cannot continue to exert the same force achieved in starting without damaging its power unit. The continuous TE of a diesel-electric locomotive is about 50 percent of its starting TE.

Starting TE corresponds to the adhesion of the driving wheels to the rails. If the TE expended exceeds this adhesion element, the drivers will slip. Normally, the adhesion element is 30 percent of the weight on drivers for dry rails and 20 percent for wet rails for an average of 25 percent. The estimated starting TE for a locomotive is, therefore, 25 percent of its weight on drivers.

For an 80-ton (160,000-pound) locomotive on drivers:

Starting TE = 25% x 160,000 lb = 40,000 lb

For a steam locomotive with starting TE of 40,000 pounds:

Continuous TE = Starting TE = 40,000 lb

For a diesel-electric locomotive with starting TE of 40,000 pounds:

Continuous TE = 50% x 40,000 lb = 20,000 lb

Drawbar Pull

Drawbar pull is the pulling ability of a locomotive less the effort needed to move the locomotive. Tests have shown that 16 to 20 pounds of pull per ton are needed to start the average locomotive or freight car on straight, level track under favorable weather and temperature conditions. A locomotive or car having roller bearings will start with somewhat less effort.

For railway planning, use 20 pounds per ton. Resistance drops after equipment starts rolling. However, to establish pulling ability (drawbar pull) available for starting and pulling a train, subtract 20 pounds per ton of locomotive weight from the continuous TE of the locomotive. A diesel-electric locomotive having a weight on drivers of 80 tons and a continuous TE of 20,000 pounds has a drawbar pull of 18,400 pounds (20,000 pounds minus 1,600 pounds).

Maximum drawbar pull is exerted only at very low speeds – up to about 10 MPH – after which it drops off sharply. To obtain drawbar pull at given speeds, apply a speed factor to the maximum drawbar pull. Remember that speeds differ for different types of locomotives. For one type of steam locomotive, drawbar pull was found to diminish in inverse ratio to speed: drawbar pull was 80 percent at 20 MPH, 50 percent at 50 MPH, and 20 percent at 80 MPH. Use this inverse ratio as a rule of thumb for estimating drawbar pull of steam locomotives at various speeds. Drawbar pull diminishes more rapidly at higher speeds for diesel-electric locomotives than for steam locomotives.

Resistance Factors

Certain forces, known as resistance factors, impact on a train's operational capability and efficiency. These forces hold or retard movement. Each resistance must be factored to determine locomotive power and the total tonnage that can be handled over certain tracks at a given time.

Rolling resistance. Rolling resistance includes the forces that act on a train in a direction parallel to the track. Components of rolling resistance include friction between the railheads and the wheel treads and flanges, undulation of track under a moving train, internal friction of rolling stock, and resistance in still air. There is no absolute figure to use for rolling resistance. However, experience has led to safe average values for rolling resistance in the theater of operations. These values are shown in Table 4-2.

Grade resistance. Grade resistance is 20 pounds times the percent of grade (20 x % grade).

Curve resistance. No entirely satisfactory theoretical discussion of curve resistance has been published. However, engineers in the United States usually allow from 0.8 to 1 pound per degree of curve. Military railway planning allows 0.8 pound per degree of curve.

Table 4-1. Weight on drivers of diesel-electric locomotives

LOCOMOTIVE TYPE	WEIGHT ON DRIVERS (STONs)	HP
Multigauge, 0-6-6-0	120	1,600
Standard gauge, 0-4-4-0	60	500

Table 4-2. Average values for rolling resistance

AVERAGE VALUE	TRACK CONDITION
5	Excellent
6	Good to fair
7	Fair to poor
8	Poor
9-10	Very poor

Weather resistance. Experience and tests show that below-freezing temperatures diminish the hauling power of locomotives. Table 4-3 shows the adverse effects of lower temperatures in percentages of hauling power loss.

Wet weather is usually considered local and temporary and may be disregarded in normal planning. In countries with extended wet seasons, however, loss of TE due to slippery rails may prove serious if sanding is inadequate. The applicable reduction in TE is a matter of judgment. In general, TE will not be less than 20 percent of weight on drivers.

Gross Trailing Load

GTL is the maximum tonnage that a locomotive can move under given conditions, such as curvature, grade, and weather. Determine GTL by combining all the factors discussed in the preceding paragraphs. Use the following formula to calculate GTL:

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

where GTL = gross trailing load
DBP = drawbar pull
W   = weather resistance
RR = rolling resistance
GR = grade resistance
CR = curve resistance

When using two steam locomotives (either double-heading them or having one pull and the other push), find GTL by taking 90 percent of the total GTL of both locomotives. The 90 percent figure is based on the difficulty in perfectly coordinating the actions of two locomotive operators. However, when diesel-electric locomotives are used in multiple-unit operation, the GTL will be 100 percent of the total GTL for both locomotives since they are operated by one person from a single control.

Net Trainload

NTL is the payload carried by the train. NTL is the difference between gross weight (total weight of cars under load) and tare weight (total weight of cars empty). In military railway planning:

NTL = 50% x GTL

Train Density

The number of trains that may be safely operated over a division in each direction during a 24-hour period is known as train density. Work trains are not included when computing TD. However, work trains blocking the main track can reduce the density of a rail division. Factors affecting TD include–

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

On a single track line, passing tracks are normally 6 to 8 miles apart. Multiple tracks (three or more) are generally considered double track lines for planning purposes since it is often necessary to remove a portion of the third and fourth tracks to maintain the double-track line.

Table 4-3. Effects of temperature in percent of hauling power loss

TEMPERATURE (°F)	LOSS IN HAULING POWER (%)
Above +32	0
+31 to +16	5
+15 to 0	10
−1 to −10	15
−11 to −20	20
−21 to −25	25
−26 to −30	30
−31 to −35	35
−36 to −40	40
−41 to −45	45
−46 to −50	50

The capacity and turnover of cars and trains operating in and out of terminal yards must be considered, either from definite experience and intelligence factors or by inference from other related information. Use the formulas that follow to find reasonably accurate estimates of freight TD for lines with 20 percent passenger trains. For a single-track operation, use this formula:

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

where TD = train density
NT = number of passing tracks
1 = constant (number of trains that could be run if there were no passing tracks)
2 = constant to convert to one direction
24 = constant (number of hours per day)
S = average speed (FM 55-20)
LD = length of division

When determining the number of passing tracks, do not include those less than 5 miles apart. The passing tracks selected should be uniformly spaced throughout the division.

Double-track operations must be fluid and flexible. The number of trains in operation should not exceed the number of trains that could be cleared from either main track onto a side or passing track at any time in an emergency. Use the factors given for single tracks to find double track TD (TD2):

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

If there is not enough information available to evaluate the potential TD of a rail line, use a TD of 10 for single track and 15 for double track.

Tonnage

Net division tonnage is the payload tonnage in STONs that can be moved over a railway division (90 to 150 miles) each day. NDT includes railway operating supplies; these supplies must be programmed for movement just as the supplies of any other service. To determine NDT, multiply the NTL by the TD of the particular division. Compute NDT separately for each railway division.

There are other factors to consider when calculating NDT. For example, troop, passenger, or hospital trains will replace an equal number of tonnage (cars with loads) freight trains. When the operation of such trains is expected, make allowance in NDT estimates by adjusting the TDs of the divisions concerned. In military operations, end-delivery tonnage is that tonnage (in STONs) delivered at the end of the railway line (railhead) each day. In all rail movements, end delivery tonnage is the same as the NDT of the most restrictive division.

EQUIPMENT REQUIREMENTS

The availability of equipment in liberated or occupied territory depends on many factors including inventories, equipment condition and extent of destruction, types of fuel available, local availability of repair parts, and types of coupling devices.

Rolling Stock

There are several types of railcars. Each has its own capabilities, and each is designed to transport different types of military equipment. The commodity to be moved dictates the type of car that will be used.

Freight cars. Compute requirements separately for operations between major supply installations and areas on each line of communication:

$$\text{number of cars} = \frac{\text{daily tonnage}}{\text{average tons per car}} \times \text{turnaround time} \times 1.10$$

Use these average planning factors for net load per car:

	Standard/Broad Gauge Track (tons)	Narrow Gauge Track (tons)
US Equipment	20	15
Foreign Equipment	10	7.5

Turnaround time is the estimated total number of days required for a car to complete a round trip – the time from placement for loading at point of origin to

destination and back. Allow 2 days at origin, 1 day at destination, and 2 days transit time for each division, or major part of a division, which the cars must cross. Use this method rather than an actual hour basis to incorporate delays caused by terminal and way station switching and in-transit rehandling of trains. See Table 4-4 for required dispatch times.

Tank cars. Compute tank car requirements separately based on bulk POL requirements and turnaround time. Tank cars are computed at their full rated capacity.

Passenger cars. Passenger car requirements vary, depending on policies for troop movement, evacuation, and rest and recuperation. Theater passenger car requirements are met with local equipment.

Road locomotives. Use the following formula to determine the number of road locomotives required for operation over a given railway division:

$$\text{locomotives} = TD \times \frac{(RT+TT)}{24} \times 2 \times 1.20$$

where TD = train density

RT = running time (length of division divided by average speed)

TT = terminal time (time for servicing and turning locomotive)

24 = number of hours per day

2 = constant for two-way traffic

1.20 = constant allowing 20 percent reserve

"RT + TT" (i.e., the locomotive factor) is the percentage of time during a 24-hour period that a road locomotive is in use. The locomotive factor provides for the pooled use of motive power which may make one or more trips per day over a short division. Estimates of downtime at terminals are 8 hours for steam locomotives and 3 hours for diesel-electric locomotives.

Switch engines. The number of switch engines required at a terminal is based on the number of cars dispatched, received, or passed through the terminal each day. To allow for maintenance and operational peaks, add 20 percent to the total number of switch engines required for the railway line.

See FM 55-20 for the formula for computing switch engine requirements.

Average Speed

For planning purposes, use the data in Table 4-5 to estimate average speed values. Select the most restrictive factor of the eight factors shown. If the restrictive factor is not known, use an average speed value of 8 MPH (13 KPH) for single track and 10 MPH (16 KPH) for double track. If the most restrictive factor affects only a comparatively short distance (10 percent or less) of the division, use the next higher average speed. If the average speed falls below 6 MPH (10 KPH) because of the gradient, reduce tonnage to increase speed. (A 2 percent reduction in gross tonnage increases speed by 1 MPH.) If the ruling grade materially affects tonnage, consider using helper service.

Table 4-4. Required dispatch times

LOCATION OR TYPE OF OPERATION	DISPATCH TIME (Days)
At base of operation	2
Forward traffic	1 per division
Return traffic	1 per division
At railhead	1

Table 4-5. Impact of restrictive factors on average track speeds

	AVERAGE SPEED			
RESTRICTIVE FACTORS	Single Track MPH	KPH	Double Track MPH	KPH
Condition of Track				
Exceptionally good	12	19.3	14	22.5
Good to fair	10	16.1	12	19.3
Fair to poor	8	12.9	10	16.1
Poor	6	9.6	8	12.9
Grade %				
1 or less	12	19.3	14	22.5
1 to 1.5	10	16.1	12	19.3
1.5 to 2.5	8	12.9	10	16.1
2.5 to 3	6	9.6	8	12.9

LOADING

Many factors must be considered when selecting flat or open-top railcars, to include compliance with CONUS commercial loading rules.

Open-Top Cars

Military equipment loaded on DOD-owned cars traveling on common carrier lines in CONUS must meet the loading standards of both the carrier and the AAR. This requirement also applies to military equipment loaded on common carrier cars. Loads on foreign railroads must meet the country's blocking and lashing standards. STANAGs govern the loading of military equipment on NATO rail lines. The AAR's General Rules Governing the Loading of Commodities on Open-Top Cars (Section 6) is on file at all ITOs in CONUS and is reprinted in TM 55-2200-001-12 as Change 3. Also see Change 4 of this TM for more on loading standards.

Explosives and Other Hazardous Materials

Besides complying with applicable loading rules, personnel must adhere to laws and regulations governing HAZMAT.

Regulations, rules, and guidelines. The DOT is responsible for regulating interstate shipment and movement of all HAZMAT by rail. The US Code (Section 831 through 835, Title 18, Chapter 39) establishes DOT authority and responsibilities for handling and transporting HAZMAT. Applicable regulations are published in 49 CFR, Transportation, and reprinted in BOE Tariff 6000. These regulations set forth requirements for classifying, packaging, marking, labeling, and storing HAZMAT. They also ensure compatibility of materials and govern the placarding of containers and vehicles carrying these materials. (See Appendix E of this manual for DOT Chart 10, Hazardous Materials Marking, Labeling & Placarding Guide.) When necessary, DOD and DA may supplement DOT requirements. For more specific regulations and guidance, see the following publications:

• AR 55-355 covers transporting military explosives and HAZMAT by military or commercial carriers within CONUS. It lists AAR loading rules for safe transportation and provides information on placarding containers and vehicles. AR 55-355 requires compliance with all regulations including:

– Reporting accidents (according to AR 385-40).
– Maintaining records.
– Tracing shipments.
– Completing SF 361.
– Ensuring cargo security.

• AR 385-40 contains information on reporting accidents.

• MIL-STD-129 series provides guidance on marking packages.

• Bureau of Explosives Pamphlet 6C covers loading and bracing methods. Approval by the AAR of all loading, blocking, and bracing methods used in rail shipment of unboxed explosive projectiles, torpedoes, mines, and bombs exceeding 90 pounds is required by 49 CFR, Paragraph 173-56. Only the military is authorized to ship palletized explosive projectiles of not less than 4 1/2 inches in diameter without being boxed. Methods for bracing and blocking other than those given in this pamphlet must be submitted through military transportation channels to the BOE for approval.

• TM 9-1300-206 provides information on the care, preservation, and destruction of ammunition. It contains data on quantity-distance standards for manufacturing, storing, and transporting mass-detonating ammunition, handling, explosives, and small arms ammunition. It also includes quantity-distance classes and tables for all classes of ammunition and explosives.

• TM 55-602 offers general guidance on transporting special freight. It identifies applicable directives and regulations and agencies prescribing transportation policies.

• Army Materiel Command publications contain outloading drawings of ammunition, missile systems, special weapons, and other HAZMAT.

Bracing and blocking. When bracing and blocking, only lumber free of characteristics that impair strength

or interfere with proper nailing should be used. Do not use lumber with cross grain, knots, knotholes, cracks, or splits. Use nails IAW TM 55-2200-001-12. Nails should be long enough to ensure necessary holding power and ample penetration of car walls, floors, or bracing and blocking materials. To prevent sparks when nailing braces around packages of explosives, brass or copper hammers should be used. Drive nails holding sidewall blocking into the heavy uprights supporting the car lining. Car lining is only three-quarters or seven-eighths of an inch thick and has little holding power for large nails.

Basic precautions. Basic precautions should be followed when loading a railcar. For example, avoid placing a large shipment in one end of a car. Do not load a shipment exceeding 12,000 pounds in one end of a car unless freight will be loaded to balance the other end. Failure to observe this precaution may cause the car to derail. Never load or stow incompatible chemicals or explosives together (see 49 CFR, Parts 170 through 179). Added precautions include the following:

• When loading packages, avoid losing space by pressing each package firmly toward the end of the car.

• Avoid high pressure on small areas. Use the largest possible area of a package to resist pressures. Nail beveled boards to cover projecting metal or nails or other defects in the floor. Cars with corrugated or pressed metal unlined ends, as well as cars with bowed ends, must be boarded up at the inside of the ends to the height of the load.

• Never use cars with end doors or cars with automobile loading devices (unless the loading device is attached to the roof of the car so that it cannot fall – applicable to shipment of Class A explosives only).

• Never use refrigerated cars unless use is authorized by the carrier or owner, ice bunkers are protected by solid bracing, and nonfixed floor racks are removed.

• When loading in closed cars, secure the load so that it does not come into contact with side doors or roll and shift in-transit.

• When using lift trucks to move heavy loads in and out of cars, use a temporary steel plate or other floor protection device of suitable size to prevent the truck from breaking through the floor. Place the load in the car so that there is no more weight on one side than the other. Limit the load over truck assembly to half the load limit stenciled on the car. Cars should be loaded as heavily as possible up to the load limit stenciled on the car.

• When loading between truck centers and the ends of the car, material must not exceed 30 percent of the stenciled load limit (15 percent each end) when both ends are loaded and 10 percent when only one end is loaded. For specific guidance, refer to the General Rules section of TM 55-2200-001-12.

• When loading, blocking, and bracing ammunition for carload and less-than-carload shipments, make sure ammunition containers are tightly wedged in place at the time of loading. Bulkhead braces for partial layers must be long enough to permit nailing to upright braces behind car lining. Length will vary, depending on weight of lading supported. The filler strips nailed to the sides of the car must be extended across the doorway. No other doorway protection is required.

Dangerous cargo placards. On loaded cars, labels and placards are required for both the containers and railcars carrying explosives and other HAZMAT. For a description of labels and other placards, see 49 CFR, Parts 172 through 174, and Appendix E of this manual.

Empty tank cars and boxcars are often covered with notices warning of lingering gases and fumes. These warning cards stress that care must be used in switching the cars as well as in unloading their contents.

Cargo Security

The rail transportation industry and the shipper share responsibility for cargo security.

At origin. The shipper is responsible for the security of carload freight until the car is coupled to a locomotive or train for movement. The shipper

must be fully aware of this responsibility, which includes the following:

• Thoroughly inspecting the car before loading to ensure that it meets security and serviceability requirements. Cars with insecure doors or holes or damaged places in floors, roofs, or sides must be repaired before they are used or rejected to carrier and a substitute car provided.

• Properly loading and bracing the load and closing and sealing the car. Improperly stowed or braced loads may be damaged in movement, inviting pilferage. (See Change 4, TM 55-2200-001-12).

• Conforming to the loading standards necessary for safe movement under existing conditions.

– Sealing closed cars containing sensitive AA&E cargo with cable seal locks. If these locks are not available, use a Number 5 steel wire twist or a wire cable of larger or equivalent thickness, together with a ball-type, serialized seal to secure door hasps.

– Ensuring that shipping papers furnished the carrier specify that flame or heat-producing tools will not be used to remove sealing devices from AA&E shipments. For nonsensitive shipments other than AA&E, a ball-type, serialized seal will suffice.

– Covering shipments in open cars with securely fastened tarpaulins.

– Fastening small items shipped on flatcars securely to the car floor.

• Preparing an accurate list of contents, preparing the waybill, and affixing placards to the cars. The shipper also transmits/mails an advance notice of AA&E shipments to the consignee. After a car is loaded, sealed, and documented, it should be moved as quickly as possible.

At military installations, the originating transportation officer and commercial railway personnel must inspect all open-top cars before movement to ensure that they are loaded properly and meet clearance requirements.

In-transit. The commercial railroad (CONUS) or the TRS (overseas theaters) is responsible for the security of all in-transit carload freight from the time the car is moved from its loading point until it reaches its designated unloading point.

The originating rail carrier or the TRS prepares all car records, train documents, and other records required to speed movement and prevent loss of cars en route. When possible, cars carrying pilferable freight are grouped together to allow for the economical use of guards. Special handling is given to mail or high-priority classified traffic.

In CONUS, the appropriate Army headquarters provides train guards. In overseas theaters, military police or other units assigned or attached to the TRS for security duties provide train guards. These units also guard cars and trains during movement in railroad yards. Sensitive supplies may be guarded by personnel assigned to the car by the loading agency. The yardmaster notifies the dispatcher on receipt of cars with special guards. The yardmaster also notes receipt on the train consist, which is transmitted to yards and terminals. This notification helps avoid delays in transit and expedites placement at the destination.

Guard crews check car seals and inspect trains for security. They prepare a record, by car number, of all guarded cars in trains and note any deficiencies or incidents en route. When a relief guard takes over, the crews make a joint inspection and then sign the record.

When a "bad-order" car containing supplies subject to pilferage is "set out," a member of the guard crew stays with the car until properly relieved. Guard crews must be alert at all times, particularly when the train is stopped or passing through tunnels, cuts, and villages at slow speeds.

At destination. When carload freight is received by the designated depot, siding, or track, the consignee then becomes responsible for the shipment. Specific guidelines, if observed by the consignee, limit possibilities for loss, pilferage, or serious damage or injury. They include the following:

• Unload cars as quickly as possible.

• When removing wire seals from closed cars, be careful not to break latches on car doors. Wire cutters are recommended for this purpose.

• Record seal numbers on shipping documents.

• Do not use flame or heat-producing tools to remove sealing devices from shipments of arms, ammunition, or explosives.

CONSTRUCTION, MAINTENANCE, AND SUPPLY

The most important assets of a rail network are track and roadbeds. Construction of new trackage is performed by the CofE and general maintenance performed by TRS.

Construction Requirements

For planning purposes, a railroad division includes 90-150 principal route miles of main line single or double track. The division includes terminal operation and maintenance facilities, fueling and watering facilities, and necessary signaling equipment or interlocking facilities. Passing sidings on single-track lines, crossovers on double-track lines, and stations are located at intervals required by traffic. Normally, there is at least one spur or siding provided at each station.

The engineer service in the theater of operations is responsible for new rail construction and large scale rehabilitation. However, TRS maintenance of way personnel may be required to assist engineer personnel with rehabilitation.

See Table 4-6 for the materials and man-hours required for new construction of one mile of standard-gauge (56 1/2-inch), single-track railroad. See Table 4-7, page 4-13, for expected rehabilitation requirements for a 100-mile standard-gauge, single-track division extending inland from a port. This table shows the average percentage of demolition over the entire division. See FM 55-20 and TM 5-370 for more information.

Table 4-6. Material and man-hour requirements for railroad construction*

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
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 m)	33	10	—
Total	569	530	15,500

* Per 1 mile of standard-gauge single track.

Table 4-7. Rehabilitation requirements per railroad division

ITEM	PER 100 MILES (161 KM)	PERCENT OF DEMOLITION	REHABILITATION (Quantity)	CONSTRUCTION MATERIAL [1] STONs	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 (74 ea) linear ft	63	63	13.7
Grading and ballast	—	—	—	—	—	40.5

[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 MTONs, and 3,000 man-hours.

[2] Estimate includes ties, rails, fastenings, turnouts, tracklaying, and surfacing. It is assumed ballast is available at work sites.

[3] Includes replacing buildings 100 percent, ties 30 percent, rail and turnouts 85 percent.

Maintenance Responsibilities

Once railways are constructed and turned over to TRS for operation, the TRS assumes responsibility for all minor railway maintenance in the communications and combat zones to the forward limit of traffic. See TM 55-204 for more information. TRS responsibilities include–

• Maintaining the railway communications circuits used for railway operation and administration. (Responsibility becomes effective when all circuits on the line have been turned over to the TRS.)

• Operating railway block signals of the interlocking plants and centralized traffic control devices.

• Providing unit and intermediate maintenance of signals and control devices.

• Installing, maintaining, and operating internal communications.

The TRS is normally divided into a number of divisions for maintenance and operation. Each division is assigned a railway battalion. Each battalion

includes personnel from the railway engineering company who perform necessary maintenance of tracks and structures.

The battalion commander has overall responsibility for railway maintenance, including maintenance procedures, instructions, and work. The railway engineering company commander is the maintenance of way superintendent. As such, his responsibilities include inspecting and maintaining tracks and structures and supervising all maintenance work procedures. Platoon and section leaders supervise assigned maintenance operations.

Maintenance Categories

Army maintenance is divided into two categories – unit and intermediate. These categories are discussed here as they apply to locomotives and rolling stock.

Locomotives. Suitable inspection pits and facilities must be provided for inspection, repair, and adjustment of locomotive parts. Locomotives must be inspected periodically and maintenance documented according to rail technical manuals. See technical publications on equipment being maintained.

Maintenance on locomotives is normally performed in an enginehouse. Division locomotives are kept in good operating condition and at maximum availability. See FM 55-20 (for diesel-electric locomotives) for a general reference covering maintenance procedures at enginehouses.

Unit maintenance. Unit maintenance of locomotives consists of during-operation maintenance, inspection of visible moving-parts, and lubrication and repair or replacement of parts. The train operating company performs maintenance. The engineman is responsible for the equipment he operates. The balance of unit maintenance is the responsibility of the railway equipment maintenance company.

Intermediate maintenance. The railway equipment maintenance company performs intermediate maintenance. If repairs are not too extensive, they are made and the locomotive put back into service. If repairs are beyond railway workshop capability,

the unit makes only those repairs needed to move the locomotive to a fixed installation for repair.

Depot maintenance. Depot maintenance is not performed by the TRS. It is beyond the capability of the transportation railway equipment maintenance company and requires evacuation to CONUS or to an appropriate base or facility.

Rolling stock. Repair track installation (rip tracks) is normally set up at main terminals. Rip tracks are also located at other points of the division, such as junction points or heavy loading centers. At these points, they make repairs that cannot be made at the loading installation, avoiding moving the cars into the main terminal. The master mechanic (railway equipment maintenance company commander) is responsible for the operation of the rip tracks.

Unit maintenance. Unit maintenance includes running repairs and inspection of rolling stock. The railway battalion train maintenance sections and crews perform unit maintenance. Military or civilian car inspectors perform maintenance at the originating terminals and at inspection points en route. They also make repairs needed to ensure safe train operation.

Intermediate maintenance. Intermediate maintenance consists of running and emergency repairs that require taking the car out of service for a short time only. The railway battalion's train maintenance sections and crews and the railway car repair companies perform intermediate maintenance. Military or civilian maintenance personnel perform intermediate maintenance at a car's home terminal or a prescribed location.

Depot maintenance. Depot maintenance is not performed by TSR units.

Maintenance of Way

Certain considerations must be factored into planning and maintenance to effectively and safely operate a rail network. Roadway, track, and structure maintenance are critical elements in maintenance of way.

Roadway. Roadway maintenance keeps the part of the right-of-way on which the track is constructed in

serviceable condition. This part of the right-of-way includes excavations, embankments, slopes, shoulders, ditches, and road or stream diversions. See TM 55-204 for a detailed discussion of roadway maintenance.

Track. In a theater of operations, the track must be operable at all times. The four primary considerations in track maintenance are: gauge, surface, alignment, and dress.

The continual passing of trains around a curve eventually moves the track, altering the alignment and distorting the curve (see subparagraph, "Determining Track Curvature"). TRS maintenance of way personnel should restore the track to its correct curvature if distortion exists. They must also inspect the roadbed and track frequently for damage from sabotage, direct enemy action, or weather. Failure to do so may result in serious operating delays.

Structures. In a theater of operations, structures essential to railway operations must be maintained according to prescribed maintenance standards. These structures include bridges, culverts, tunnels, and fuel and water facilities. When repairing structures, always observe minimum clearances.

Determining Track Curvature

Degrees of track curvature impact significantly on train operation and adversely affect speeds. Track curvature is measured by either the survey or string method.

Survey method. Degree of curve (D) is a measure of the sharpness of curvature and is defined as the angle subtended at the center of curvature by a chord 100 feet long. Radius of curvature (R) is the distance (in feet) from the apex of the central angle out to the curve; mathematically, R is the reciprocal of the curvature (C) of a curve. A chord is a straight line joining two points on the curve. The arc is the continuous portion of that curved line (as a part of a circle) between the same two points. The smaller the central angle (and the greater the radius), the closer the arc measurement comes to the chord measurement (100 feet).

The area of the sector of a circle is expressed in either of two ways:

$$A = \frac{R \times arc}{2} \text{ or } A = \frac{3.1416 \times R2 \times D}{360}$$

where: A = area
R = radius of curvature in feet
D = degrees of curvature
arc = 100 ft (since arc and chord are almost the same for a 1° curve.)

To solve for R:

$$R = \frac{arc \times 360}{2 \times 3.1416 \times D} = \frac{arc \times 57.3}{D}$$

R then equals 5,730 for a 1° curve and $\frac{5,730}{D}$ for a D° curve.

Table 4-8, page 4-16, shows the relationship between degree of curve and radius of curvature for simple curves.

String method. If a surveying instrument is not available, compute the degree of simple curvature (arc of a circle) of a track by the string method. Although this method is not exact, the degree of error is slight. A length of ordinary field commo wire makes an ideal string. Commo wire is readily available, will not stretch, and can be rolled up and carried in the pocket. Take the following steps to determine the degree of track curvature by the string method:
• Select a portion of track well within the main body of the curve.
• Mark a 62-foot section on a length of wire or strong cord with dabs of white paint at the beginning (A), middle (M), and end (B) of the section.
• Secure A to inside of high rail (5/8 inch from top). Tightly stretch wire until B touches inside of rail (Figure 4-3, page 4-16).
• Measure the distance R from M to inside of rail. Distance in inches equals approximate degree of curve. If the distance R from M to rail measures 5 inches, then the degree of curve is 5. As a curve gets sharper, the distance R increases.

Supply Procedures

Railway supplies are expendable supplies required for the operation and maintenance of railway

divisions. At the beginning of operations, all operating units must submit reports of supplies on hand. Railway supplies are distinguished from organizational supplies. Whenever possible, use local supply sources to reduce transportation requirements. In a theater of operations, sources of railway supplies include–
• Military stocks.
• Manufacturers in or near the theater.
• Foreign railways.
• Captured enemy material and equipment.
• Parts and assemblies manufactured or repaired by other railway units.
• Transfers from other railway operation units.

The battalion supply officer serves as fuel agent for the railway transportation battalion. Fuel agents must ensure that the operating TRS agencies receive enough locomotive fuel, regardless of the source. Fuel and lubricants are requisitioned through normal supply channels.

The supply officer of the highest transportation railway echelon prepares tables of allowances and supplies for all units within the command. To ensure uninterrupted operations, the supply officer determines a workable stock level allowance for each unit.

Stock levels for the railway division are usually determined from past requirements. To estimate repair parts requirements, use the factor 1.5 STONs per month for each train moving in each direction per day. Beginning with the first railway division, select the train density established for the division and multiply by 2 (for two-way travel). Then multiply the result by 1.5 for the total amount in STONs of spare parts required per month for this division. Use this process for each successive division to determine the total STONs required per month for the entire railway system. This total is an estimate only and should be revised to fit operating conditions.

Table 4-8. Degree of curve and radius of curvature for simple curves

D	R	D	R	D	R
1	5,730	7	819	13	441
2	2,865	8	716	14	409
3	1,910	9	637	15	382
4	1,433	10	573	16	358
5	1,146	11	521	17	337
6	955	12	478	18	318
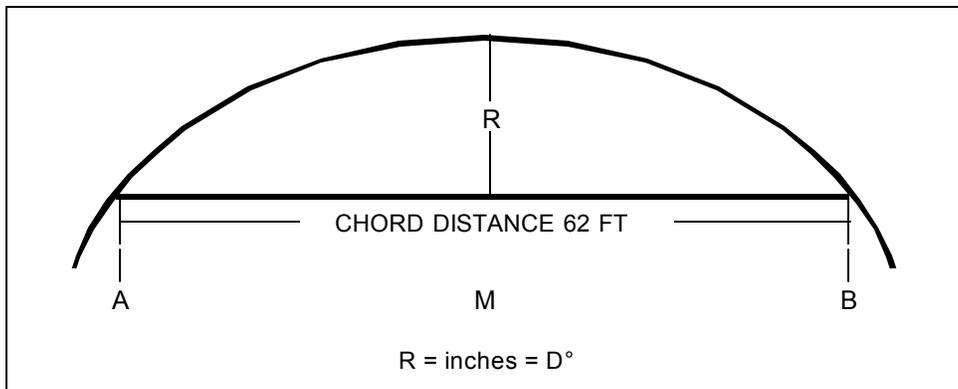
Figure 4-3. Determining curvature (string method)

Section II
RAIL TRANSPORT DATA

LOCOMOTIVE CLASSIFICATION

Different classification systems exist for locomotives in CONUS and most other countries throughout the world. Understanding the systems described in this section is essential in planning rail operations.

Whyte System

This system classifies locomotives by wheel arrangement. The Army uses the Whyte System. Although originally developed for steam locomotives, this system may be used for any type of motive power. Three or more digits separated by a hyphen designate the number of wheels on the locomotive. The first digit represents the number of leading or "guide" wheels, the second the number of drive wheels, and the third the number of trailing wheels. If there are no trailing wheels, then the figure "0" is used in each case. Two separate sets of driving wheels are shown as two separate digits – always with a hyphen between them. For example:

• 2-8-2. Denotes a locomotive with one pair of leading wheels, four pairs of coupled driving wheels, and one pair of trailing wheels.

• 2-8-0. Denotes a locomotive with one pair of leading wheels, four pairs of coupled driving wheels, and no trailing wheels.

• 0-6-6-0. Denotes a locomotive with no leading or trailing wheels and two sets of three driving wheels each.

Continental System

The classification system commonly used in Europe and other parts of the world classifies locomotives by axles rather than wheels. Powered axles are represented by letters – "A" being one powered axle, "B" two powered axles, "C" three, and so on. Nonpowered or idling axles are represented by numerals. Using this system, the Army 0-4-4-0 would be a "B-B" and the 0-6-6-0 would be a "C-C." A 2-8-0 steam locomotive would be a 1-D-0. A locomotive with two six-wheeled trucks would not necessarily be equipped with all axles powered, usually the middle axle being an idler. This locomotive would then be shown as an "A-l-A+A-l-A," the plus sign (+) representing the separation of the front and rear trucks.

RAILWAY EQUIPMENT CHARACTERISTICS

The Official Railway Equipment Register provides data on DOD cars under MTMC control. This publication also contains data on all US rolling stock and is updated quarterly. The ITO at each CONUS installation should have the most current edition on hand. See Tables 4-9 through 4-19, pages 4-18 through 4-26, for railway equipment characteristics as follows:

• Motive power.
– Locomotives – Table 4-9, page 4-18.
– Locomotive cranes – Table 4-10, page 4-20.
– Railway maintenance motor cars – Table 4-11, page 4-21.
• US rolling stock.
– Open-top cars (gondolas and hopper cars) – Table 4-12, page 4-21.
– Flatcars – Table 4-13, page 4-22.
– Boxcars – Table 4-14, page 4-22.
– Refrigerator cars – Table 4-15, page 4-22.
– Tank cars – Table 4-16, page 4-23.
– Special-purpose cars – Table 4-17, page 4-23.
• German rolling stock – Table 4-18, page 4-24.
• Korean rolling stock – Table 4-19, page 4-26.

Table 4-9. Characteristics of locomotives

TYPE	GAUGE (in)	WEIGHT (lb)	LENGTH OVER COUPLERS	EXTREME WIDTH	EXTREME HEIGHT	TRACTIVE FORCE (LB) Starting at 30% Adhesion	TRACTIVE FORCE (LB) Continuous	HORSE-POWER	CURVATURE MINIMUM RADIUS (ft)	FUEL CAPACITY (gal)
Diesel-Electric:										
131-T, 0-6-6-0, domestic and foreign svc	56 1/2	262,900	55'	10' 0"	14' 0"	75,700	37,850 at 10 MPH	1,000	231	1,600
127-T, 0-6-6-0, domestic and foreign svc	56 1/2	261,100	55'	10' 0"	14' 0"	75,700	37,850 at 10 MPH	1,000	231	1,600
120-T, 0-6-6-0, domestic and foreign svc	56 1/2, 60, 63, 66	240,000 / 245,000 w/steam generator	57' 5"	9' 8"	13' 6"	73,000	37,000 at 10 MPH	1,600	193	1,600 / 800 w/steam generator
120-T, 0-6-6-0, domestic and foreign svc	56 1/2, 60, 63, 66	240,000 / 245,000 w/steam generator	56' 9"	9' 7"	13' 5"	72,000	36,000 at 10 MPH	1,600	193	1,600 / 800 w/steam generator
120-T, 0-4-4-0, domestic svc	56 1/2	240,000	55' 9"	10' 3"	14' 6"	75,000	40,000 at 11 MPH	1,500	150	800
120-T, 0-4-4-0, domestic svc	56 1/2	246,000	48' 10"	10' 2"	14' 6"	73,000	36,000 at 10 MPH	1,200	100	750
115-T, 0-4-4-0, domestic svc	56 1/2	230,000	45' 6"	10' 0"	14' 6"	69,000	34,000 at 15 MPH	1,000	50	635
100-T, 0-4-4-0, domestic svc	56 1/2	199,000	44' 6"	10' 0"	14' 4"	59,700	28,750 at 10 MPH	660	50	635
100-T, 0-4-4-0, domestic svc	56 1/2	200,000	44' 5"	10' 0"	14' 7"	69,700	35,000 at 10 MPH	800	100	600
80-T, 0-4-4-0, domestic svc	56 1/2	161,000	36' 10"	9' 6"	13' 7"	48,000	24,000 at 10 MPH	500	75	400
80-T, 0-4-4-0, domestic svc	56 1/2	161,000	36' 10"	9' 6"	13' 7"	48,000	24,000 at 10 MPH	470	75	400
80-T, 0-4-4-0, domestic svc	56 1/2	161,600	41' 0"	9' 6"	13' 4"	48,000	21,000 at 5.2 MPH	550	75	400

Table 4-9. Characteristics of locomotives (continued)

TYPE	GAUGE (in)	WEIGHT (lb)	LENGTH OVER COUPLERS	EXTREME WIDTH	EXTREME HEIGHT	TRACTIVE FORCE (LB) Starting at 30% Adhesion	Continuous	HORSE-POWER	CURVATURE MINIMUM RADIUS (ft)	FUEL CAPACITY (gal)
Diesel-Electric (continued):										
65-T, 0-4-4-0, domestic svc	56 1/2	130,000	34' 0"	10' 11"	13' 5"	39,000	19,500 at 10 MPH	400	75	250
60-T, 0-4-4-0, domestic and foreign svc	56 1/2, 60, 63, 66	122,000	38' 11" (Type E) 39' 3" (Willison)	9' 6"	13' 4"	26,000	15,680 at 7.78 MPH	500	75	500
45-T, 0-4-4-0, domestic and foreign svc	56 1/2	90,000	33' 6"	9' 7"	12' 0"	27,000	12,000 at 6 MPH	380	75	250
45-T, 0-4-4-0, domestic svc (side rod drive)	56 1/2	90,000	28' 4"	9' 6"	12' 0"	27,000	13,500 at 6.2 MPH	300	50	165
44-T, 0-4-4-0, domestic svc	56 1/2	91,270	33' 10"	9' 4"	13' 3"	26,400	11,000 at 9 MPH	380	75	250
44-T, 0-4-4-0, domestic svc	56 1/2	99,000	33' 5"	10' 1"	13' 3"	26,400	13,000 at 7.1 MPH	380	50	250
25-T, 0-4-0, domestic svc	56 1/2	50,000	16' 1"	8' 7"	10' 4"	15,000	6,200 at 6.2 MPH	150	50	75
Gasoline/Diesel-Mechanical:										
10-T, single-engine, 0-4-0, domestic svc	56 1/2	20,000	—	—	—	—	—	100	75	30 (diesel)

Table 4-10. Characteristics of locomotives cranes

TYPE	GAUGE (in)	WEIGHT (lb)	LENGTH OVER COUPLERS	EXTREME WIDTH	EXTREME HEIGHT	BOOM LENGTH (ft)	REACH RADIUS AND CAPACITY	
							Main Hoist	Aux Hoist
Locomotive, steam, wrecking, 75-T, broad gauge, domestic and foreign svc	56 1/2, 60, 63, 66	191,000	30' 10"	17' 10"	10' 4"	25 (2-piece, curved)	16' (75-T) 25' (34-T)	25' (10-T) 30' (8-T)
Locomotive, crane, diesel, mech, 150-T, domestic svc	56 1/2	291,700	31' 0"	15' 6"	10' 4"	28 (2-piece, straight)	28' (67-T)	—
Locomotive, diesel, elec, 40-T, broad gauge, domestic and foreign svc	56 1/2, 60, 63, 66	221,500	36' 1"	13' 6"	10' 4"	50 (2-piece, straight)	12' (40-T) 50' (6 3/4-T)	— —
Locomotive, diesel, elec, 40-T, domestic svc	56 1/2	220,000	29' 4"	15' 1"	10' 6"	50 (2-piece, straight)	12' (40-T) 50' (6 3/4-T)	— —
Locomotive, diesel, mech, 25-T, broad gauge, domestic and foreign svc	56 1/2, 60, 63, 66	148,000	27' 7"	13' 0"	8' 6"	50 (2-piece, straight)	12' (25-D 50' (4-T)	— —
Locomotive, diesel, mech, 25-T, narrow gauge, foreign svc	36, 39 3/8, 42	152,000	32' 6"	12' 0"	8' 6"	40 (2-piece, straight)	12' (25-T) 40' (6-T)	— —
Locomotive, diesel, mech, 25-T, domestic svc	56 1/2	155,000	30' 0"	15' 2"	10' 8"	50 (2-piece, straight)	12' (25-T) 50' (4-T)	— —
Locomotive, diesel, mech, 35-T, domestic svc	56 1/2	167,000	30' 0"	15' 7"	10' 4"	50 (2-piece, straight)	12' (35-T) 50' (5-T)	— —

Table 4-11. Characteristics of railway maintenance motor cars

TYPE	GAUGE (in)	WEIGHT (lb)	LENGTH (in)	WIDTH (in)	HEIGHT (in)	CAPACITY	HORSE-POWER	FUEL CAPACITY (gal)
Gasoline, mech, 4 wheels, solid drawbar couplers, closed cab with cabhand brake	56 1/2	2,950	112	65	58 w/o cap	8 person	62.6	8
Gasoline, mech, 4 wheels, solid drawbar couplers, open body with hand brake	56 1/2	1,700	103	65	50	10 person	62.6	8

Table 4-12. Characteristics of open-top cars

TYPE	GAUGE (in)	NORMAL CAPACITY (lb)	(cu ft)	INSIDE DIIMENSIONS Length	Width	Height	LIGHT WEIGHT (STON s)
Gondolas:							
High side, 8W, narrow gauge, foreign svc	36, 39 3/8, 42	60,000	940	34' 5"	6' 10 1/2"	4'	13.0
Low side, 8W, narrow gauge, foreign svc	36, 39 3/8, 42	60,000	356	34' 6"	6' 10 1/2"	1' 6"	12.1
High side, 8W, broad gauge, foreign svc	56 1/2	80,000	1,680	40'	8' 3 3/4"	4'	18.0
Low side, 8W, broad gauge, foreign svc	56 1/2, 60, 63, 66	80,000	500	40' 4 1/2"	8' 3 1/4"	1' 6"	16.0
Low side, 8W, drop ends, domestic svc	56 1/2	100,000	1,184	41' 6"	9' 6 1/8"	3'	23.0
High side, std gauge, domestic svc	56 1/2	100,000	1,580	41' 6"	9' 6"	4' 6"	25.0
Hopper Cars:							
8W, domestic svc	56 1/2	100,000	—	33'	9' 5 1/2"	9' 7"	—

Table 4-13. Characteristics of flatcars

TYPE	GAUGE (in)	NORMAL CAPACITY (lb)	PLATFORM LENGTH	PLATFORM WIDTH	PLATFORM HEIGHT ABOVE RAIL	LIGHT WEIGHT (STONs)
8W, narrow gauge, foreign svc	36, 39 3/8, 42	60,000	34' 8 1/2"	7' 2"	3' 7"	10.9
12W, domestic svc	56 1/2	200,000	54'	10' 6 1/2"	4' 1 1/4"	35.0
8W, domestic svc	56 1/2	140,000	49' 11 1/2"	10' 3 1/4"	3' 8 1/2"	27.0
12W, broad gauge, foreign svc, 80-T	56 1/2, 60, 63, 66	160,000	46' 4"	9' 8"	4' 2 7/8"	35.3
12W, domestic svc (passenger train svc)	56 1/2	200,000	54'	10' 6 1/4"	4' 5 3/8"	—
8W, domestic svc	56 1/2	100,000	43' 3"	10' 6"	3' 8"	25.5
8W, broad gauge, foreign svc	56 1/2, 60, 63, 66	80,000	40' 9"	8' 7 1/4"	3' 6 15/16"	14.5
8W, broad gauge, depressed center, foreign svc	56 1/2, 60, 63, 66	140,000	50' 7"	9' 8"	NA	41.5

Table 4-14. Characteristics of boxcars

TYPE	GAUGE (in)	CAPACITY (lb)	CAPACITY (cu ft)	INSIDE DIMENSIONS Lenth	INSIDE DIMENSIONS Width	INSIDE DIMENSIONS Height	DOOR DIMENSIONS	LIGHT WEIGHT (STONs)
8W, domestic svc	56 1/2	100,000	3,975	50' 6"	9' 3"	10' 6"	10' wide, clear opening .8' high, clear opening	23.0
8W, broad gauge, foreign svc	56 1/2, 60, 63, 66	80,000	2,520	40' 6"	8' 6"	6' 5 5/8"	6' 8 3/4" wide 8' 3 1/4" high	18.5

Table 4-15. Characteristics of refrigerator cars

TYPE	GAUGE (in)	NORMAL CAPACITY (lb)	LENGTH INSIDE SIDE LINING	WIDTH INSIDE SIDE LINING	ICE CAPACITY (lb)	DOOR DIMENSIONS
8W, disassembled, foreign svc	56 1/2	80,000	38' 9 1/2"	6' 11"	11,000	4' wide 7' high
8W, disassembled, broad gauge, foreign svc	56 1/2, 60, 63, 66	80,000	32' 1/2"	7' 8" (approx)	11,000	4' wide 7' high
8W, mechanical, foreign svc	56 1/2, 60, 63, 66	80,000	40' 9" equipment compartment	7' 6" (approx)	None	6' wide 7' high

Table 4-16. Characteristics of tank cars*

TYPE	WHEEL GAUGE	CAPACITY (gal)	MAXIMUM CAPACITY (lbs)	LIGHT WEIGHT (STONs)	PRESSURE
DOT-103W General Purpose	56 1/2	Various	110,000	30	<101 psi
DOT-103AW Nickel-clad	56 1/2	Various	119,000	30	<101 psi
DOT-105S500W Insulated (Compressed Gases)	56 1/2	Various	135,000	40	500 psi
DOT-111A100W1 Insulated	56 1/2	Various	200,000	35	100 psi
DOT-111A100W1 Insulated (Caustic Soda Service)	56 1/2	15,000+	200,000	33	100 psi
DOT-111A60ALW2 (Nitric Acid Service)	56 1/2	15,000+	200,000	25	60 psi

*See UTLX or GATX Tank Car Manuals for detailed tank car specifications.

Table 4-17. Characteristics of special-purpose cars

TYPE	GAUGE (in)	WEIGHT (LB) Light	WEIGHT (LB) Loaded	OVER END SILLS Length	OVER END SILLS Width	HEIGHT ABOVE RAIL	REMARKS
Car, amb unit, 8W, domestic svc	56 1/2	157,000	167,300	78' 11"	10'	13' 6"	Capacity: 27 patients, 6 corpsmen, 1 nurse, 1 doctor
Car, guard, domestic svc	56 1/2	92,740	99,300	57'	9' 1"	14' 2 1/2"	Air-conditioned, shower, toilet, kitchen, 2 sleeping compartments
Car, kitchen, troop/ amb train, 8W, domestic svc	56 1/2	100, 160	NA	54' 2 1/2"	9' 5 3/4"	13' 6"	Width, side door opening: 6'
Car, kitchen, dining and storage, amb train, 8W, foreign svc	56 1/2, 60, 63, 66	111,400 (avg)	NA	63' 1/4"	9'	13'	Seat capacity: 24
Car, personnel, amb train	56 1/2, 60, 63, 66	111,400 (avg)	NA	63' 1/4"	9'	13'	Berth capacity: 15 EM, 4 doctors, 2 nurses

Table 4-18. Characteristics of German freight cars

TYPE	NUMBER OF AXLES	LIGHT WEIGHT (STONs)	CAPACITY WEIGHT (STONs)	CUBE (cu ft)	INSIDE DIMENSIONS			DOOR DIMENSIONS		HEIGHT OF FLOOR ABOVE TOP RAIL
					Length	Width	Height	Width	Height	
Boxcar, G	2	11.4	16.5	1,500	25' 11 3/4"	8'	7' 4 9/16"	4' 11 1/16"	6' 6 11/16"	4' 1/16"
Boxcar, GLMHS-50	2	13.4	23.1	2,500	36' 9 5/16"	8' 11 1/16"	9' 5/8"	6' 6 1/16"	6' 6 11/16"	4' 9/16"
Boxcar, GM-30	2	12.7	23.1	1,700	24' 10"	8' 10"	31' 4"	5' 6"	6'	not avail
Boxcar, GMS-54	2	12.6	23.1	2,100	30' 5 11/16"	8' 8 11/16"	8' 9 1/2"	5' 10 13/16"	6' 7 1/8"	4' 1/16"
Boxcar, KMMKS-51	2	12.5	30.8	1,420	28' 8 13/16"	9' 5/8"	5' 6 1/8"	5' 10 13/16"	4' 10 5/8"	4' 1 7/16"
Boxcar, KMM8KS-58	2	14.3	29.7	1,800	28' 8 9/16"	8' 11 1/16"	7' 1 5/16"	12' 8 3/4"	6' 6 11/16"	4' 11/16"
Gondola, X-05 (low side)	2	not avail	23.1	320	25' 7"	8' 7"	1' 4"	NA	NA	not avail
Gondola, XLM-57 (low side)	2	8.4	23.1	330	29' 7"	8' 6"	1' 4"	NA	NA	4'
Gondola, OMM-37 (high side)	2	9.7	24.6	1,210	27' 7"	9'	4' 10"	NA	NA	4'
Gondola, OMM-52 (high side)	2	11.0	28.6	1,200	28'	8'	4' 10"	NA	NA	4'
Gondola, OMM-55 (high side)	2	11.0	27.5	1,200	28' 8 9/16"	9' 3/8"	4' 11 1/16"	5' 10 1/2"	NA	4' 7/8"
Gondola, OMM-53 (high side)	2	12.1	27.5	1,200	28'	8' 9"	4' 10"	NA	NA	4'
Gondola, OMM-33 (high side)	2	11.5	27.0	1,260	28' 7 3/16"	9' 7/16"	5' 1"	4' 11 1/16"	NA	4' 5/8"
Flatcar, R-10[1]	2	10.6	16.5	NA	33' 25/16"	8' 9"	NA	NA	NA	4'
Flatcar, RM-31[1]	2	14.3	22.1	NA	34' 11 9/16"	8' 6 5/16"	NA	NA	NA	4' 1 1/8"
Flatcar, RMM-31[1]	2	11.4	27.0	NA	34' 8 3/8"	9' 2 1/4"	NA	NA	NA	4' 1 1/4"
Flatcar, RLMMS-50[1]	2	14.0	25.3	NA	40'	8' 11"	NA	NA	NA	4'
Flatcar, SM-14[1]	2	11.9	23.1	NA	41' 6"	8' 9"	NA	NA	NA	not avail
Flatcar, SS-15[1]	4	21.5	40.2	NA	48' 2"	8' 9"	NA	NA	NA	not avail
Flatcar, SSLMA-44	4	22.7	44.1	NA	59' 2 7/16"	9' 1/4"	NA	NA	NA	4' 5 3/4"

Table 4-18. Characteristics of German freight cars (continued)

TYPE	NUMBER OF AXLES	LIGHT WEIGHT (STONs)	CAPACITY WEIGHT (STONs)	CUBE (cu ft)	INSIDE DIMENSIONS Length	INSIDE DIMENSIONS Width	INSIDE DIMENSIONS Height	DOOR DIMENSIONS Width	DOOR DIMENSIONS Height	HEIGHT OF FLOOR ABOVE TOP RAIL
Flatcar, SSLMAS-53	4	26.3	61.6	NA	60' 8 5/16"	8'11 13/16"	NA	NA	NA	4' 6 1/8"
Flatcar, SSKM-49	4	17.1	55.1	NA	40' 8 3/4"	8' 5 15/16"	NA	NA	NA	4' 3 9/16"
Flatcar (USA-owned)	4	16.7	50.0	NA	40' 9"	8' 5 3/4"	NA	NA	NA	4' 3 9/16"
Tank car	2	14.0	NA	(2)	21' 2"	NA	not avail	NA	NA	5'
Tank car	4	26.4	NA	(3)	33' 1/2"	NA	not avail	NA	NA	5'
	(MTs)	(MTs)	(cu m)	(m)	(m)	(m)	(m)			
RS 683,684,685	4	24.0	56.0	51.3	18.5	2.77	NA	NA	NA	1.33
RS689	4	23.6	56.0	51.0	18.5	2.77	NA	NA	NA	1.33
REMMS665	4	21.4	58.5	35.1	12.6	2.78	NA	NA	NA	1.33
RES686	4	25.0	55.0	49.0	18.5	2.75	NA	NA	NA	1.23
SA705	6	22.3	67.5	35.3	11.2	2.73	NA	NA	NA	1.43
SA (h) S710	6	31.0	65.0	45.7	15.0	2.56	NA	NA	NA	1.37
SAhs 711	6	31.5	64.0	turning side jacks flooding molds	NA	2.90	NA	NA	NA	NA
SGjs 716 (w)718	4	24.0	18.8	55.0	2.7	NA	NA	NA	NA	1.24
shis	4	22.7	NA	NA	NA	NA	NA	NA	NA	NA
SAS709	6	30.6	65.0	46.0	15.0	3.09	NA	NA	NA	NA
TS851	2	11.7	28.0	24.0	8.76	2.76	1.37	NA	NA	1.25
TCS850	2	11.6	28.0	24.0	8.66	2.76	1.68	NA	NA	1.25
TlS858	2	13.0	26.5	23.8	8.75	2.72	1.68	NA	NA	1.23
Tbis871	2	15.1	24.5	34.0	12.7	2.67	2.16	NA	NA	1.17
Tbis 869, 870, 875	2	14.4	25.5	34.0	12.7	2.67	2.26	NA	NA	1.17

1 Height of flatcar is determined by height of stanchion.
2 4,356 US gallons.
3 14,266 US gallons.

Table 4-19. Characteristics of Korean freight cars

| TYPE | NUMBER OF AXLES | LIGHT WEIGHT (STONs) | CAPACITY | | INSIDE DIMENSIONS (M) | | | DOOR DIMENSIONS (M) | | HEIGHT (M) OF FLOOR ABOVE TOP OF RAIL |
			WEIGHT (lb)	CUBE (cu m)	Length	Width	Height	Width	Height	
Boxcar:										
40-T	4	21	88,160	87	12.95	2.7	2.5	1.7	2.1	1.1
50-T	4	22	110,200	95	13.04	2.8	2.6	1.8	2.1	1.6
Gondola:										
40-T	4	19	88,160	40	11.00	2.6	1.4	NA	NA	1.1
50-T	4	20	110,200	49	13.04	2.7	1.4	NA	NA	1.6
Flatcar:										
40-T	4	16	88,160	NA	12.20	2.5	NA	NA	NA	1.1
50-T	6	20	110,200	NA	15.00	2.9	NA	NA	NA	1.2
Tank car (USA-owned)	4	22	88,160	(10,000 gal)	11.09	2.9	2.7	NA	NA	1.1

CLEARANCES AND TRACK GAUGES

Overhead and side clearances must be known before a load plan can be developed. Any equipment exceeding published clearance must be approved by the shipping industry prior to loading.

Standard Clearances

Overhead clearances and platform heights are measured from top of rail; side clearances are measured from centerline of track. See Table 4-20, page 4-27, and Figure 4-4, page 4-27 for standard minimum clearances. Local conditions may call for greater clearances.

Composite Clearance Diagrams

Sample clearance diagrams (Figure 4-5, page 4-28, and Figure 4-6, page 4-29) show the distances that equipment or cargo may project to the sides at various heights above track level. The diagrams are composites of the minimum dimensions of all similar structures in the countries listed (with corresponding track gauges) in Table 4-21, page 4-30. Not all of the limiting clearances shown in the composites will exist at once on any particular rail line. A clearance diagram must be obtained or made for the rail line being operated. Do not confuse horizontal distances shown in the diagrams with track gauge.

For example: In Figure 4-5, a vertical clearance of 3 feet 8 inches corresponds to a width clearance of at least 9 feet 8 inches. A vertical clearance of 9 3/4 inches corresponds to a width clearance not less than 8 feet 1 1/2 inches. In Figure 4-6, a vertical clearance between 13 3/4 inches and 3 feet 4 inches results when the width clearance is not more than 8 feet.

BRIDGE CAPACITY

Bridges are designed to carry specific concentrated loads safely. The best formula for determining a bridge capacity is the Cooper's E-rating.

Cooper's E-rating

The weight, in thousands of pounds, that a bridge can support for each driving axle of a locomotive is

referred to as the Cooper's E-rating of the bridge. Military railroad bridges are normally designed for a Cooper's E-45 rating but may be built for lighter or heavier loads. To determine the required Cooper's E-rating of a bridge for a particular locomotive, divide the locomotive's weight on drivers by its number of driving axles.

For example, for a 2-8-0 (steam) locomotive weighing 140,000 pounds on drivers to cross a bridge safely, the bridge must have a rating of E-35 or above:

$$\frac{140,000}{4} = 35,000$$

Table 4-20. Standard minimum clearances – wires, buildings, and other structures

ITEM	CLEARANCE		ITEM	CLEARANCE	
	(m)	(ft in)		(m)	(ft in)
Overhead clearances:			Side clearances:		
Wires:			Buildings	2.59	8' 6"
High voltage	8.53	28' 0"	Canopies:		
Other	8.23	27' 0"	Up to 15' 6"	2.59	8' 6"
Structures	6.71	22' 0"	Higher than 15' 6"	1.68	5' 6"
			Platforms:		
			3' 9"	1.88	6' 2"
			4'	1.52	5' 0"
			Refrigerator platforms:		
			3' 2"	1.88	6' 2"
			4' 7"	2.59	8' 6"
			Enginehouse entrance:		
			Overhead	5.18	17' 0"
			Side	1.98	6' 6"

Figure 4-4. Standard minimum clearances – single-track bridges and tunnels

Figure 4-5. Composite clearance diagram for standard-gauge (56 1/2 in)
and broad-gauge (60, 63, and 66 in) track
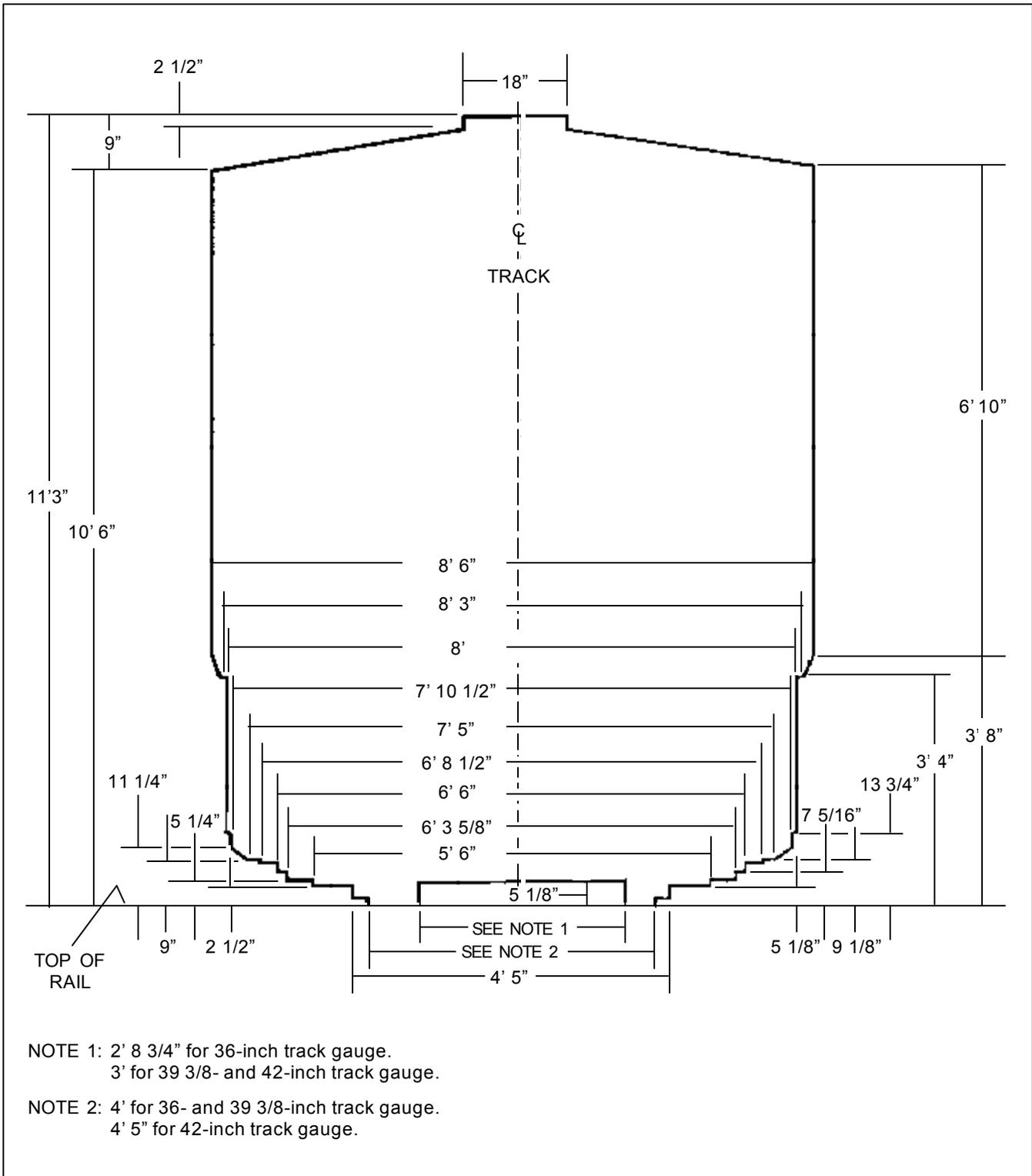
Figure 4-6. Composite clearance diagram for narrow-gauge (36, 39 3/8, and 42 in) track

NOTE 1: 2' 8 3/4" for 36-inch track gauge.
3' for 39 3/8- and 42-inch track gauge.

NOTE 2: 4' for 36- and 39 3/8-inch track gauge.
4' 5" for 42-inch track gauge.

Table 4-21. Track gauges of the world*

COUNTRY	GAUGES (MM)**	COUNTRY	GAUGES (MM)**
Albania	1,435	Greece	1,435; 1,000; 750; some dual gauges
Algeria	1,432; 1,055		
Angola	1,067; 600	Guatemala	914
Argentina	1,000; 1,435; 1,676	Guinea	1,000
Armenia	1,520	Honduras	1,067; 1,057; 914
Australia	1,435; 1067; 1,600	Hong Kong	1,435
Austria	1,435; 760; 1,000	Hungary	1,524; 1,435; 760
Azerbaijan	1,520	India	1,676; 1,000; 762; 610
Bangladesh	1,676; 1,000	Indonesia	1,067; 750
Belarus	1,520	Iran	1,435; 1,676
Belgium	1,435	Iraq	1,435
Benin	1,000	Ireland	1,600
Bolivia	1,000	Israel	1,435
Bosnia-Hercegovina	1,435	Italy	1,435; some 1,000 and 950
Botswana	1,067		
Brazil	1,600; 1,000; 762; 1,440	Ivory Coast	1,000
Bulgaria	1,435; 760	Jamaica	1,435
Burkina Faso	1,000	Japan	1,067; 1,435; 1,372; 762
Cameroon	1,000	Jordan	1,050
Canada	1,435	Kampuchea	1,000
Chile	1,676; 1,000; 1,435	Kazakhstan	1,520
China, PR	1,435; some 750	Kenya	1,000
Columbia	914; some 1,435	Kirgizia	1,520
Congo	1,067	Korea, North	1,435; some narrow gauge
Costa Rica	1,067	Korea, South	1,435; 762
Croatia	1,435	Latvia	1,520; 750
Cuba	1,435	Lebanon	1,435
Czech Republic	1,435; 750; 760	Liberia	1,435
Denmark	1,435	Libya	No operating railroads
Dominican Republic	1,435; 762	Lithuania	1,520; 1,435; 750
Ecuador	1,067	Luxembourg	1,435
Egypt	1,435	Macedonia	1,435
El Salvador	914	Madagascar	1,000
Eritrea	950	Malawi	1,067
Estonia	1,520	Malaysia	1,000
Ethopia	1,000	Mali	1,000
Finland	1,524	Mauritania	1,435
France	1,435; 1,000	Mexico	1,435; 914
Gabon	1,435	Moldova	1,520
Georgia	1,520	Mongolia	1,520
Germany	1,435; some narrow gauge	Morocco	1,435
Ghana	1,067	Mozambique	1,067

Table 4-21. Track gauges of the world* (continued)

COUNTRY	GAUGES (MM)**	COUNTRY	GAUGES (MM)**
Myamar (Burma)	1,000	Sudan	1,067
Namibia	1,065	Swaziland	1,067
Nepal	762	Sweden	1,435
Netherlands	1,435	Switzerland	1,435; 1,000
New Zealand	1,067	Syria	1,435
Nicaragua	1,067	Tadjikistan	1,520
Nigeria	1,067; 1,435	Taiwan	1,067
Norway	1,435	Tanzania	1,000
Pakistan	1,676; 1,000	Thailand	1,000
Panama	914; 1,524	Togo	1,000
Paraguay	1,435	Tunisia	1,435; 1,000
Peru	1,435; 914	Turkey	1,435
Philippines	1,067	Turkmenistan	1,520
Poland	1,524; 1,435; 1000; 785; 750; 600	Uganda	1,000
		Ukraine	1,520
Portugal	1,668; 1000	United Kingdom	1,435; 1,600
Puerto Rico	1,000	United States	1,435
Romania	1,435; 1,524; 760	Uruaguay	1,435
Russia	1,520; 1,067	Uzbekistan	1,520
Saudi Arabia	1,435	Venezuela	1,435
Senegal	1,000	Vietnam	1,435; 1,000
Slovakia	1,435; 1,520; 1,000; 750	Yugoslavia (Serbia and Montenegro)	1,435
Slovenia	1,435		
South Africa	1,065; 610	Zaire	1,067
Spain	1,668; 1,435; 1,000	Zambia	1,067
Sri Lanka	1,676; 762	Zimbabwe	1,067

 * From Janes World Railways, 1995-96.

** To convert to inches, multiply milimeters by 0.04.

Steel I-Beam Bridges

Use Table 4-22, page 4-32, to determine capacity of steel I-beam bridges constructed with two, four, six, or more steel stringers or girders of equal dimensions. Assume one stringer per rail. Measure the width and thickness of the lower flange of one stringer at the center of the span length (Figure 4-7, page 4-33). Also measure the depth and length of the stringer. Then select the steel stringer that is nearest these dimensions and find the corresponding E-rating of the bridge. The age and condition of a bridge can reduce its E-rating. The quantity of this reduction must be determined by qualified personnel, normally from the Corps of Engineers. See FM 5-446 for more information concerning bridge capacities.

Wooden Bridges

Use Table 4-23, page 4-33, to determine the capacity of railway bridges with wooden stringers. Measure the width of each stringer under one track at the

center of the longest span and add the measurements to obtain total stringer width. In Figure 4-8, page 4-34, the total stringer width is 2 x W. Also measure the depth and length of one stringer. Then refer to the table to find the corresponding E-rating.

MAXIMUM BULK LOADS

A car's rated load limit does not mean that it can carry the rated tonnage of all items. For many types of cargo, cubic capacity is reached before rated weight capacity. When this occurs, the tonnage of the maximum cubic capacity of the car represents its actual capacity.

Freight cars loaded with high-density items can nearly always be loaded to their rated capacity. Examples of high-density items are ammunition, barbed wire, cement, flour, gravel, corrugated iron, rails, rifles in chests, sand, stone, and engineer tools. See Table 4-24, page 4-34, for rated and actual capacities for some lighter bulk items.

Table 4-22. Capacity (E-ratings) – steel I-beam bridges

STRINGER DIMENSIONS (in) Thickness	Width	Depth	BRIDGE CAPACITY (E-RATING) SPAN LENGTH (ft) 10	11	12	13	14	15	16	17	18	19	20	22	24
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						
1/2	10 3/8	30			E-61	E-59	E-51	E-46	E-41	E-37	E-33	E-30	E-27		
1/2	12 1/2	30				E-62	E-56	E-50	E-45	E-41	E-37	E-31	E-26		

Thickness	Width	Depth	17	18	19	20	22	24	26	28	30	35	40	44	50	54	60	64
1	14	36	E-60	E-58	E-55	E-54	E-51	E-48	E-43	E-39	E-34	E-26						
1/2	12 3/8	42		E-60	E-54	E-45	E-39	E-34	E-30	E-26								
1 1/8	14	42			E-63	E-60	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	16	48								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
1 1/2	14	60											E-57	E-48	E-38	E-33	E-27	

Thickness	Width	Depth	50	54	60	64	70	74	80	84	90
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 1/2	72			E-55	E-51	E-43	E-38	E-33	E-29	
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	
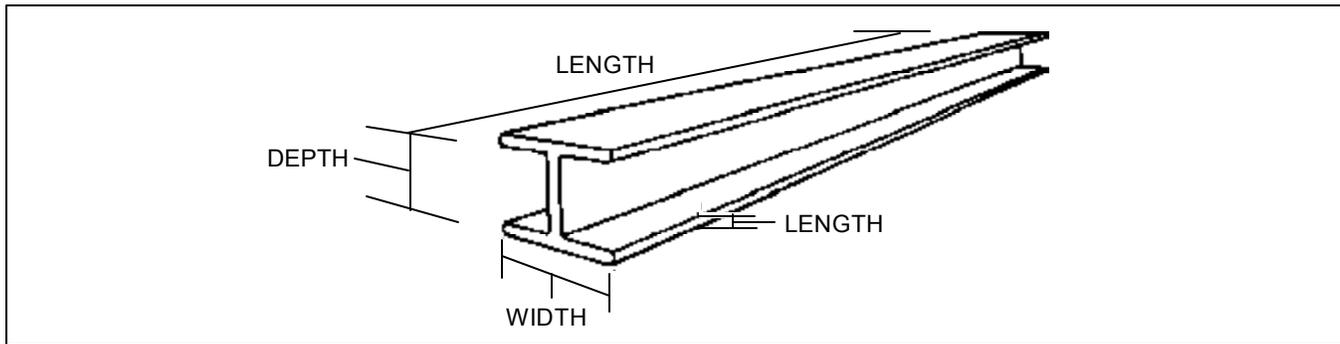
Figure 4-7. Dimensions of a steel stringer

Table 4-23. Capacity (E-ratings) – wooden bridges

STRINGER DIMENSIONS (in)		BRIDGE CAPACITY (E-RATING) SPAN LENGTH (ft)						
Width	Depth	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
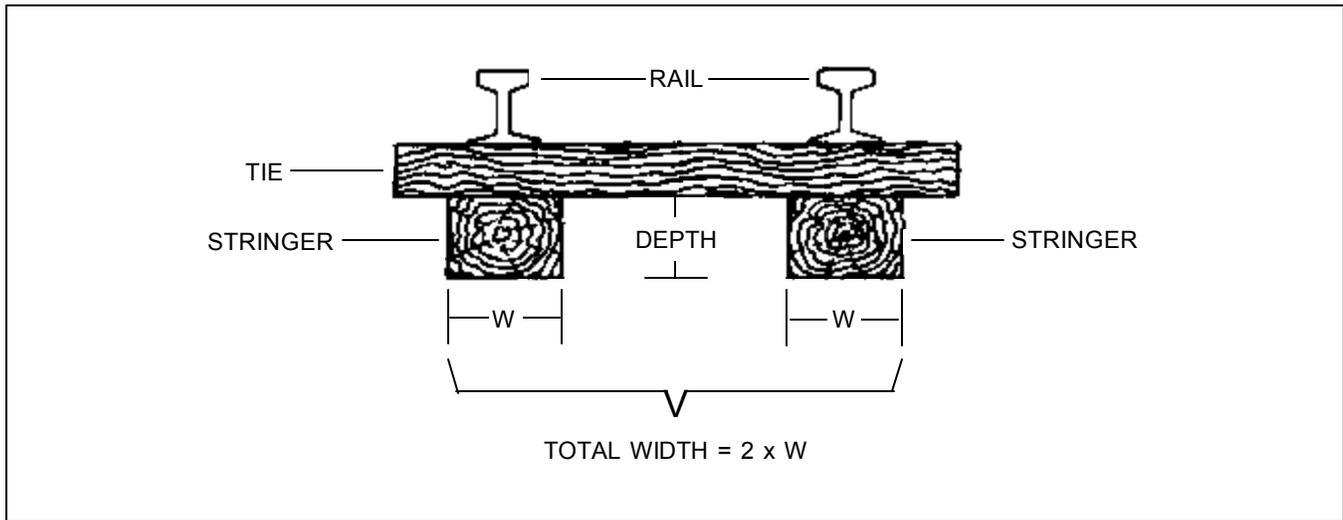
Figure 4-8. Dimensions of a wood stringer

Table 4-24. Car capacity for some low-density items

	CAR CAPACITY (STON s) RATED		
	30	40	50
ITEM	Actual		
Blankets, baled	27	32	40
Bread	19	24	30
Canned goods, boxed	30	36	45
Clothing, baled	27	32	40
Meat	15	24	35
Motor vehicle parts	24	28	40
Sandbags	21	24	30
Tentage	15	20	30
Ties, railroad	19	26	32