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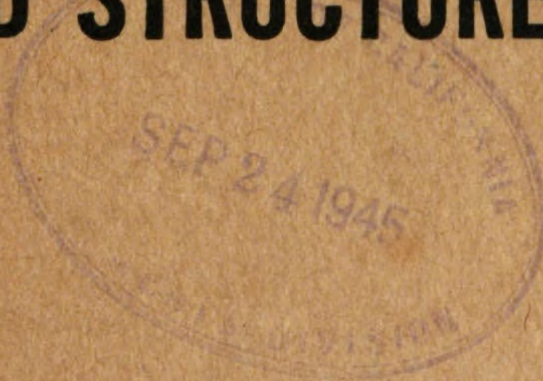
WAR DEPARTMENT TECHNICAL MANUAL

U.S. Dept of Army

OPERATION OF RAILROADS

MAINTENANCE OF WAY

AND STRUCTURES



WAR DEPARTMENT

JULY 1945

WAR DEPARTMENT TECHNICAL MANUAL
TM 55-275

This manual supersedes TM 55-275, 4 February 1944

OPERATION OF RAILROADS
MAINTENANCE
OF WAY AND
STRUCTURES



WAR DEPARTMENT



JULY 1945

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BY ORDER OF THE SECRETARY OF WAR:

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PART ONE

GENERAL INSTRUCTIONS

CHAPTER 1

INTRODUCTION

1. PURPOSE AND SCOPE. a. This manual contains regulations and instructions which govern personnel of War Department railroads charged with the maintenance of way and the maintenance of structures. It does not cover maintenance of signal equipment. (For signals, see TM 55-277.)

b. The duties of certain supervisory personnel outlined in part three of this manual will not be construed as interfering with or supplanting the function of command. General duties of supervisory personnel are stated in FM 55-50 and 55-55. Additional details of these duties are set forth in this manual.

c. No set of regulations can be promulgated to cover all conditions and circumstances of operation; special instructions will be issued by the proper authority to cover unusual situations.

2. WAR DEPARTMENT RAILROADS. War Department railroads include all military railroads, all railroad companies being operated by the War Department, and all utility railroads serving War Department installations. The mission of United States military railroads is to provide efficient and dependable transportation by rail of troops, equipment, and supplies required by the military forces. The mission of utility railroads is to provide efficient and dependable rail transportation for War Department installations.

3. RESPONSIBILITY. Commanding officers of personnel assigned to maintenance of way and maintenance of structures will provide each individual whose duties are prescribed in this manual with a copy and will be responsible that they understand and observe these regulations.

4. APPENDIXES. Definitions of terms used in this manual will be found in appendixes I, II, and III.

CHAPTER 2

REGULATIONS

5. TIMETABLE. Personnel whose duties are affected by train movements will carry a copy of the current timetable while on duty; they will observe instructions therein and will know the arrival time of trains at the point of their work. Superseded timetables will be destroyed.

6. PROTECTING TRAINS. Personnel will promote the safe operation of trains, observing the following instructions:

a. General. Report to the train dispatcher and the nearest bridge or section foreman, any accident, defect, or obstruction in track, bridges or equipment, giving all facts and particulars necessary for a clear understanding of the situation. Use the quickest and most reliable means of communication available.

(1) Do not throw switches for trainmen except to prevent accidents.

(2) Observe derails to see that they are set and locked in position to derail, regardless of whether or not cars are on the tracks they protect.

b. During work. Work will be arranged, if possible, to make track and bridges passable for trains, especially for scheduled trains. Provide full protection to personnel and trains if it is necessary to work on track or track structures during fogs or heavy storms.

c. Emergencies. Report by the quickest and most reliable means available any condition such as floods, storms, fires, or enemy action which may affect the safety of trains. Observe the following instructions:

(1) Patrol track during threatening or prevailing storms, making frequent inspections of bridges, tunnels, snowsheds, culverts, and the like in localities in which track may be affected.

(2) Inspect track and structures before permitting their use.

(3) Stop trains when necessary; forbid traffic on any damaged bridge or track until it has been pronounced safe by the proper authority.

d. Conductor's call. A conductor may call on any available personnel for assistance if trains are delayed by accident or by other cause. Foremen will respond promptly when so called and, if necessary, will assist with their entire force.

7. PROTECTING PERSONNEL. Be careful to prevent accidents to yourself and others, taking the safest course when in doubt. Be alert for trains at any time and from either direction on any track. Do not place yourself in dangerous positions unless emergency situations require it, and then only on orders of supervisory personnel. All personnel will have a copy of TM 55-281 (when published) and will observe its safety rules.

8. DEATHS. Supervisory personnel will report promptly to the proper authority any death from accident, enemy action, or other cause occurring within his jurisdiction.

9. GENERAL MAINTENANCE. **a. Obstructions.** (1) Take prompt action to remove track obstructions and to make repairs.

(2) Trees or shrubs on waylands that obstruct the view of track or signals, or that might fall and obstruct track, will be removed; if such trees or shrubs are off the right-of-way, they will be removed only with the owner's permission.

b. Emergencies. In emergencies the person upon whom the responsibility logically falls will take authority when authority is not designated. He will report progress of work as required.

c. Estimates. The amount of material required for maintenance will be estimated carefully before it is requisitioned.

d. Security. A guard will be stationed when security of property or freight is involved.

e. Reports. Completion of repairs will be reported promptly if traffic has been interrupted.

10. COMMUNICATIONS AND POWER CIRCUITS.

Telephone and telegraph wires will be used only when necessary; personal messages will be offered for transmission only in extreme emergency.

a. Identification. An authorized person using a train dispatcher's wire will first identify himself and give his location.

b. Maintenance. Make every effort to prevent interruption of communications and power circuits. Observe the following instructions:

(1) Know the location of train order wires and give them preference in repairing circuits.

(2) Take precautions to avoid damaging circuits when doing work on the right-of-way, especially when using a derrick or pile driver, and when blasting or burning.

(3) Remove shrubs, trees, limbs, and hanging wires which may interrupt or damage circuits.

(4) Remove all scrap wire from the right-of-way.

c. Reports. Train dispatcher will be informed of damaged circuits and notified when temporary or permanent repairs have been made.

11. STANDARD TIME.

Standard time obtained from Military Railway Service Headquarters, Railway Grand Division Headquarters, or any other authorized source, will be transmitted to all points at 1200 hours (noon) daily, or at any other time prescribed by the general manager, Military Railway Service. Observe the following regulations:

a. Watches. Watches will be carried on duty by personnel authorized to do so by T/O & E 55-227.

b. Watch comparison. Watches will be examined and certified by a watch inspector. Personnel inaccessible to watch inspectors will compare watches frequently with standard clocks or with watches of train crews to make sure that any variation is not more than 30 seconds daily.

c. Watch certificates. Watch inspection certificates (WD AGO Form 55-219) will be renewed and filed each month with the division superintendent.

12. VIOLATIONS. Personnel will report by locomotive or train number all locomotives or trains that disregard signals, fail to answer stop signals, or exceed the speed prescribed by slow order.

13. JURISDICTION. Personnel whose duties require service on more than one division or district are under the jurisdiction of the officers of the division or district on which the service is being performed.

CHAPTER 3

PROTECTION

Section I. SIGNALS

14. GENERAL RULES. **a. Equipment.** Personnel whose duties require them to give signals will provide themselves with the proper signaling devices (red flag, fuses, and torpedoes in the daytime and red light, fuses, and torpedoes at night) and keep them in good working order, ready for immediate use.

b. Emergency stop. Any object waved violently by anyone on or near the track is a signal to stop.

c. Imperfect signal. The most restrictive indication will be regarded as given under the following circumstances (the day indication will govern when it is plainly seen):

(1) The absence of a signal at a place where a signal is usually shown.

(2) The absence of a light, or the display of a white light, where a colored light should be displayed.

(3) Any signal imperfectly displayed.

d. Reports. A signal imperfectly displayed, or the absence of a signal at a place where one usually is shown, will be reported promptly to the train dispatcher.

e. Acknowledgment. When any signal except a fixed signal is given to stop a train, it will be acknowledged as prescribed by paragraph 19h.

15. COLOR SIGNALS. The following table governs color signals:

<i>Color</i>	<i>Indications</i>
Red	Stop.
Yellow	Proceed at reduced speed, and for other uses prescribed by the rules.

<i>Color</i>	<i>Indications</i>
Green	Proceed, and for other uses prescribed by the rules.
Green and white....	Station flag stop. (See par. 18.)
Blue	Stop. Men working under locomotive or cars. (See par. 30.)
Lunar white.....	Train order signal marker, and for other uses.
Purple.....	Stop (indication for dwarf signals).

16. FUSEES. Lighted fusees are signals for trains or locomotives to stop and then proceed at reduced speed.

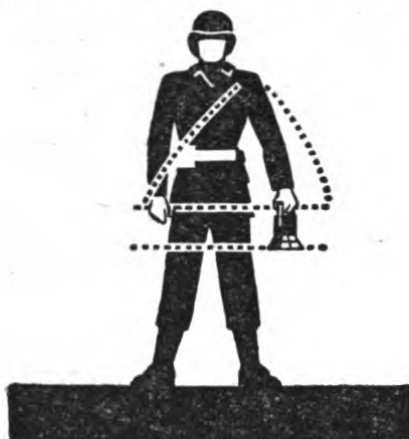


Figure 1. STOP. Lamp swung across the track.



Figure 2. REDUCE SPEED. Lamp held horizontally at arm's length.



Figure 3. PROCEED. Lamp raised and lowered vertically.



Figure 4. BACK. Lamp swung vertically in a circle at half arm's length across the track.

17. **TORPEDOES.** The explosion of two torpedoes is a signal to proceed at reduced speed. The explosion of one torpedo will indicate the same as two, but the placing of two is required.

18. **HAND, FLAG, LAMP.** A green and white signal will be used to stop a train only at flag stations on its schedule. A red signal will be used to stop a train at a point that is not a flag station on its schedule. Other hand, flag, or lamp signals will be given as illustrated in figures 1 to 7, inclusive.



Figure 5. TRAIN HAS PARTED. Lamp swung vertically in a circle at arm's length across the track.

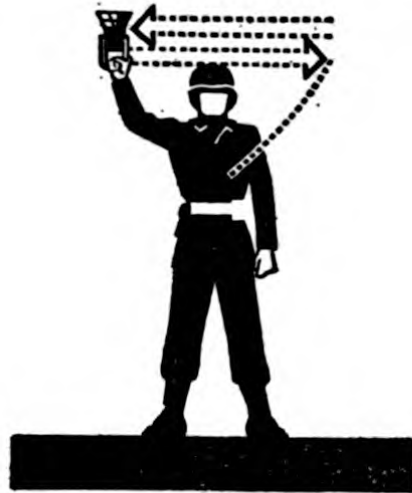


Figure 6. APPLY AIR BRAKES. Lamp swung horizontally above the head when standing.



Figure 7. RELEASE AIR BRAKES. Lamp held at arm's length above the head when standing.

The hand or a flag moved as illustrated with a lamp will give the same indication, except that in figure 1, the hand or flag movement may be above the shoulder.

19. LOCOMOTIVE WHISTLES. In the following table, locomotive whistle signals are illustrated by "o" for short sounds, and by "—" for longer sounds. The sound of the whistle should be distinct, with intensity and duration proportionate to the distance the signal is to be conveyed:

<i>Sound</i>	<i>Indication</i>
a. o	Apply brakes. Stop.
b. — —	Release brakes. Proceed.
c. — o o o	Flagman protect the rear of the train.
d. o o o —	Forward trainman or fireman protect ahead.
e. — — — —	Flagman may return from west or south.
f. — — — — —	Flagman may return from east or north.
g. — — —	Train is parted.
h. o o	Answer to k below or any signal not otherwise provided for.
i. o o o	Answer to figure 4. When standing, back. When running, answer to station stop signal.
j. o o o o	Call for signals.
k. — o o	Single track—to call attention of locomotive and train crews of trains of the same class, inferior trains and yard locomotives, and of trains at train order meeting points, to signals displayed for a following section. If not answered by a train, the train displaying signals must stop and ascertain the cause.
	Two or more tracks—to call attention of locomotive and train crews

- of trains of the same class, inferior trains moving in the same direction and yard locomotives, to signals displayed for a following section.
- l. — — o — Approaching public crossings at grade. To be prolonged or repeated until the crossing is reached.
- m. — Approaching stations, junctions, railroad crossing at grade, and mail cranes located between stations.
- n. — — o Approaching meeting or waiting points.
- o. o — Inspect train line for a leak or for brakes sticking.
- p. o o o o o o o o Alarm for persons or livestock on the track (continued as necessary).
- q. — o When running against the current of traffic:
 (1) Approaching stations, curves, or other points where the view may be obscured.
 (2) Approaching passenger or freight trains and when passing freight trains.
 (3) Preceding the signals prescribed by e and f above.
- r. o o — Engineman in charge of the second locomotive operate air brakes.

20. TRAIN AND LOCOMOTIVE LIGHTS. a. **Headlight.** A headlight will be displayed at the front of trains at night, during heavy storms or fogs, and when proceeding through tunnels. It will be extinguished:

- (1) When a train is on a siding and clear of the main track.

(2) When a train is standing to meet a train at the end of two or more tracks, or at a junction.

b. Tender light. A white light will be displayed at the rear of the tender when a locomotive is running backward at night, in heavy storms or fogs, or through tunnels.

c. Yard locomotives. Yard locomotives will display headlights at the front and rear by night. When a headlight is not provided at the rear, another type of white light will be displayed. All other locomotives in yards at night without cars will display a headlight at the front and a white light at the rear.

21. TRAIN MARKERS. One flag or one light displayed on trains where two are prescribed will indicate the same as two, but the proper display of signals is required as follows:

a. Rear. The following signals will be displayed on each side of the rear of every train as markers to indicate the rear of the train:

(1) When running by day, unlighted marker lamps.

(2) When running at night on a main track, lights showing green to the front and side, and red to the rear.

(3) When clear of the main track, lights showing green to the front, side, and rear.

(4) Where their use is authorized, markers displaying yellow lights instead of green will be respected the same as green.

b. Front. The following signals will be displayed on the front of locomotives:

(1) Two green flags, and in addition, two green lights by night, in the places provided for that purpose on all sections except the last.

(2) Two white flags, and in addition, two white lights by night, in the places provided for that purpose on extra trains.

(3) When two or more locomotives are coupled, each will display the signals.

22. TRAIN DEFECTS. The following are signals to indicate mechanical or other defects to crews of passing trains:

a. Hot journal. By day, nose held with one hand and the other hand pointed toward the passing train. By night, lamp held by the guard wire and swung vertically in a small circle.

b. Brakes sticking. By day, hands shoved in a sliding motion, palms together (as in washing hands) out from the body. By night, similar motion with lamp.

c. Other defects. To indicate a broken wheel, defective truck, dragging brake connection, lading shifted over the end or side of a car, swinging car door, or any other dangerous condition, give the stop signal (fig. 1).

Section II. USE OF SIGNALS

23. PRESCRIBED TYPES. Flags of the prescribed color will be used by day, and lights of the prescribed color by night. Day signals will be displayed from sunrise to sunset, but when day signals cannot be seen plainly, night signals will be used in addition. Night signals will be displayed from sunset to sunrise.

24. LOCATION. Signals of the color type will display their indications by lights of prescribed color as viewed from an approaching train.

25. SWITCH TARGETS. Main track switch targets will show green to an approaching train when switches are set for the main track, and red when they are set for sidings, cross-overs, or junction tracks. All other switch targets will show green or yellow. Spring switches will be indicated by reflector signs with letters "SS" on switch targets.

26. TORPEDOES. **a. Placing.** Torpedoes will be placed on the engineman's side and two rail lengths apart. They will not be placed near public or private crossings, stations, or other buildings, nor where their explosion may endanger any person or property.

b. Track cars. (1) A sufficient number of torpedoes will be carried at all times on track cars.

(2) Torpedoes exploded, damaged by, or removed for a track car will be replaced.

27. **FUSEES.** Fusees will not be placed between rails where practicable to avoid it, on road crossings, on or within 100 feet of bridges, or where a fire hazard might be created.

28. **FLAGGING.** Before any main track is made impassable or obstructed, a competent flagman who is instructed properly and understands flagging rules will be sent in each direction by the foreman. The foreman is responsible for knowing that signals are displayed properly and that flagging rules are being observed.

a. **Distance.** The flagman will unroll his flag and proceed to a flagging point that is a sufficient distance from the obstruction to insure protection, but in no case less than 4,000 feet. Where the view is obscured, on descending grades, or if other conditions require, the flagman will go as much farther as necessary to reach a point where he is certain he can be seen by the engineman in time to make a safe stop.

b. **Procedure.** At the required distance from an obstruction, the flagman will:

(1) Place a stop signal (par. 18) on a staff outside the track on the engineman's side.

(2) Place torpedoes approximately four rail lengths farther away from the stop signal and the obstruction.

(3) Leave the torpedoes to be exploded unless an approaching train stops before reaching them.

(4) Explain fully to the engineman the nature and location of the obstruction and then remove torpedoes, replacing them in every case after the train has proceeded.

(5) Stop all trains approaching the obstruction and continue protection until relieved or recalled by the proper authority.

(6) The flagman beyond an obstruction will remove the torpedoes and stop signals after a train has passed the obstruction and replace them after it has passed the signal location.

c. Emergency. If a train is heard or seen approaching before the flagman has reached the required distance, he will immediately place a stop signal and two torpedoes, and will display a red signal while continuing as rapidly as possible in the direction of the approaching train.

29. CAUTION SIGNALS. If conditions prevent the passage of trains at normal speed, but will permit the passage of trains at reduced speed, place caution signals (yellow), protecting each track in multiple track territory. Proceed signals (green) will be placed at points where normal speed may be resumed.

a. Distance. Caution signals will be placed not less than 4,000 feet on each side of the point where the slow track begins, and farther if necessary.

b. Speed restrictions. Caution signals will restrict speed to 15 miles per hour unless another speed is specified by train order, bulletin, special instructions, or by black numerals on a yellow disc displayed at the point where the slow track begins. Where a permanent speed restriction is required, standard yellow triangular signs with black numerals will be located on the engineman's side of the track 1,500 feet from the slow track. Where two speeds are shown, the upper is for passenger trains, and the lower for freight trains.

30. BLUE SIGNALS. A blue signal will be displayed at one or both ends of a locomotive, car, or train when workmen are under or about it, and when thus protected it will not be coupled to or moved. Only the same workmen who display blue signals are authorized to remove them. Do not place other cars on the same track so as to obstruct the view of the blue signals without first notifying the workmen.

31. TRAIN DEFECTS. Personnel will observe passing trains for defects. One previously designated person should stand on the side of the train opposite the other personnel. If nothing irregular is noted, personnel will give the proceed signal (fig. 3) to the rear of passing trains. If defects are noted, they will signal the train crew in accordance with paragraph 22.

Section III. TRAIN ORDERS

32. **WARNING.** Trains will be warned by train order of any temporarily defective bridge or track. When there is no further necessity for a slow order, it will be annulled promptly to avoid unnecessary delay to trains.

33. **SLOW ORDERS.** Slow train orders will give locations of obstructions and indicate the speed (in multiples of five) that is safe. Where speed of 5 miles per hour is required, track will be protected by flagmen.

CHAPTER 4

EQUIPMENT

Section I. TOOLS AND MATERIAL

34. CARE AND USE OF TOOLS. The following instructions govern the care and use of tools:

a. Inventory. List of tools to be kept on hand will be approved by the maintenance of way superintendent, signed by supervisory personnel, and posted in tool houses, tool cars, and other such places. Report any tool overage or shortage to supervisory personnel.

b. Security. Keep tools locked in a toolbox or tool house. Do not lend tools without authorization.

c. Inspection. Inspect tools when they are received and report their condition to supervisory personnel. Foremen will advise superior officers of comparative service given by tools of different manufacture.

d. Replacement. Tools requiring repairs will be tagged to show their return address and will be shipped as directed. Exchange worn tools when new ones are needed; new tools will not be provided otherwise without sufficient reason.

35. MATERIAL. **a. Inventory.** Report to supervisory personnel any overages or shortages of material.

b. Inspection. Inspect material when it is received and report its condition to supervisory personnel.

c. Unloading. Unload material promptly when it is received and notify the proper authority when cars are released.

d. Distribution. (1) Pile material neatly at least 8 feet from the nearest rail, never between sidings and main tracks, or on a highway.

(2) Do not distribute material between tracks, through station grounds, or in yards, except when it is to be used the same day.

e. Disposal and salvage. (1) Material removed in work on track through station grounds and in yards will be picked up and disposed of properly at the end of each day's work. If this is not practicable, provide adequate safeguards and, if necessary, restricting orders.

(2) Usable second hand material will be utilized for repair work in preference to new material so far as practicable.

(3) Roadway material assembled at section headquarters will be assorted under the direction of the foremen, and serviceable material will be made available for further use. Mechanical and roadway material, and other metal scrap, will be placed in designated bins and shipped as directed.

f. Loading. Observe the following rules in loading material:

(1) Load limits of cars will not be exceeded.

(2) Piles, timbers, and other bulky objects will be loaded in such a manner as to insure safe passage over bridges and through tunnels.

(3) Cars will be well staked and secured at the top by wire or by cross timbers bolted or securely spiked to the stakes if necessary.

(4) Material extending over two or more cars will rest on cross pieces at least 6 inches high. It will be placed to distribute the weight equally on the trucks and to permit the cars to ride freely around curves.

Section II. TRACK CARS

36. TERMINOLOGY. The terms "cars" or "track car" as used in this section will apply to motorcars, hand cars, velocipedes, trailers, and push cars.

37. MAINTENANCE AND EQUIPMENT. The following instructions will be observed in the maintenance and equipment of track cars:

a. Readiness. Keep cars ready for instant use and equipped with safety rails and tool guards at the front and rear.

b. Inspection. Make careful inspections before starting on trips, testing brakes to make sure they work properly. Inspect cars at sufficient intervals to prevent failures due to broken or defective parts; order replacement parts in time to avoid interruption of a car's service.

c. Cooling system. Drain water from the cooling system of a car which is not in operation for an extended period. Use an antifreezing mixture in radiators during cold weather or take other precautions to insure that the cooling system does not freeze.

d. Repairs. Send cars to a shop for repairs only when authorized after an inspection by a repairman or by supervisory personnel. Avoid shipping cars on trains when possible. In case of a break-down, notify the proper authority promptly and list repair parts needed.

e. Security. Keep cars housed or locked securely when not in use.

f. Signal equipment. Carry the following signal equipment on cars ready for instant use: (daytime) 12 torpedoes, two red flags, and six fuses; (night) two red lights, two white lights, 12 torpedoes, and six fuses.

38. FIRE PREVENTION. The following precautions will be observed to prevent fires:

a. Fuel. (1) Do not carry gasoline on cars in excess of the usual fuel supply except in drums, underwriters'-approval safety cans, or in permanently installed containers.

(2) Do not use any car with a leak in the gasoline line.

(3) Drain gasoline from cars before shipping them.

b. Smoking. Do not smoke or use matches, torches, or any other open flame lights near motorcars while they are being inspected or while gasoline tanks are being filled.

c. Location. Set cars off track where there is no danger of their being damaged by fire from burning grass or other combustible material.

39. OPERATION LIMITS. Except in emergencies, track cars will not be operated beyond their section limits or assigned territory without authorization; cars will be used only for railroad business and during usual working hours.

40. DUTIES. Operators of track cars will report to and receive instructions from section foremen or other supervisory personnel; operators will be responsible for proper care and efficient operation of their machines. Each man in a gang will have a clear understanding of his duties in handling a track car.

41. STARTING. In starting a motorcar engine, pull UP on the crank when the piston is compressing the charge in the cylinder; otherwise the crank may "kick" backward and cause injury if the charge is ignited before the piston is at the top of its stroke.

42. ALERTNESS. When operating a track car, be alert for trains or other cars to appear from either direction without notice.

43. KNOWLEDGE OF TRAINS. The foreman or operator of a track car will obtain information concerning the movement of trains before going to work and as often as necessary thereafter. If possible, obtain such information from the train dispatcher. Operation on any one of multiple tracks makes knowledge of opposing trains essential.

44. UNUSUAL CONDITIONS. Special care will be taken when it is necessary to operate cars during storms, in fogs, at places where the view is obscured, or when heavy loads or insufficient clearances prevent removing cars from the track quickly. Push cars will not be operated in fogs, storms, or at night unless it is necessary, and then only with a foreman in charge.

45. FLAG PROTECTION. Track cars will proceed under flag protection if conditions require it. Loaded push cars will always be protected in both directions by flagmen.

46. SETTING OFF CARS. Cars will not be left unprotected on the main track, on sidings, or obstructing highways. When they are at the point of work, but not in actual use, lift them off the track and place them entirely clear of passing trains. Where practicable, set them off in sight of personnel or keep them locked.

47. SPEED. Cars will not exceed a speed of 6 miles per hour when passing through stations or yards, over switches, through interlockings, over frogs, railroad, highway, or farm crossings at grade. At all other points motorcars are restricted to speeds as follows: Gang cars without trailers, 20 miles per hour; gang cars with trailers, 15 miles per hour; light inspection cars, 20 miles per hour.

48. CONTROL. Motorcars will be kept under complete control and stopped, if necessary, when approaching grade crossings or workmen on or near track. Before proceeding, make certain that travelers or workmen will not be endangered, and that traffic at protected crossings has been stopped. Care will be exercised in passing a train receiving or discharging passengers at a station. Do not pass between a train and the platform unless proper safeguards are provided.

49. SIGNAL TERRITORY. Cars will be stopped before passing over interlocked derails or switches. When such a derail or switch is set against a car, it may be lifted over if the signal operator indicates it is safe to proceed. Non-insulated track cars will not be operated within track circuit limits without authorization.

50. SWITCHES AND FROGS. Switches will be thrown only when cars cannot be lifted over, and then only under the direction of supervisory personnel. At such times switches will be returned immediately to the proper position and locked. Cars will not be run through spring switches or through the spring rail side of frogs.

51. SAFE DISTANCES. Motorcars will not follow within 1,000 feet, and push cars within 400 feet, of other moving cars or trains.

52. COUPLING. Track cars will not be attached to trains. Motorcars will not be coupled together except when one is disabled and is being towed.

53. RIDING AND BOARDING. Only personnel with proper authority or in the discharge of duties may ride on a track car. At least one man on a gang car will face the rear and watch for trains; no one will be permitted to sit on ends of cars. Moving cars may be boarded only from the rear.

54. TOOLS AND MATERIAL. Rails, ties, and other heavy material will not be carried on motorcars except in emergencies, and then under the protection of flagmen in both directions. Water kegs, track jacks, and other tools or material that might derail cars will be carried only on the sides or at the rear.

55. PRIVATE OR FOREIGN CARS. Foremen will not allow private track cars on tracks without permission from the division superintendent. Cars assigned to one railroad will not be run on another railroad without authorization by the proper authority on each line.

Section III. WORK TRAINS

56. RIDING, BOARDING, AND ALIGHTING. Only assigned or authorized personnel will be permitted to ride on work trains. They will not jump on or off trains while they are in motion or ride in places where they will be exposed to danger.

57. LOADING AND UNLOADING. Cars will be kept balanced in loading and unloading material; unbalanced loads may derail cars. Scrap or other loose material on flat cars will be secured with end boards, sideboards, and good stakes (par. 37f).

CHAPTER 5

SAFETY AND SECURITY

Section I. SAFETY OF PERSONNEL

58. REFERENCE. Knowledge of regulations contained in TM 55-281 and TM 20-350 (when published) is required of all personnel of War Department railroads.

59. SIGNALING. When obedience to signals is essential to the safety of any person in the performance of his duty, he will make sure that the signals have been seen, understood, and obeyed before placing himself in a dangerous position.

a. Confusion. Be careful to prevent confusion of "Caution" and "Stop" signals when two gangs are working close together. Foremen will confer to arrange for full protection of work as provided by the rules, and both will be held responsible for any misunderstanding.

b. Full protection. Foremen will neither assume nor accept assurances that no trains are expected, but will at all times protect personnel with signals conforming to the flagging rule.

Section II. FIRE PREVENTION AND DEMOLITIONS

60. HANDLING. The handling and storage of explosives, inflammables, and other dangerous articles will be governed by AR 700-10, 750-10, and 850-20; by TM 9-1900, TM 9-2900, and TM 55-281 (when published); and by O. O. Form 7224 (Ordnance Safety Manual). In addition, the following general regulations will be observed:

a. **Smoking.** Smoking and the use of open flame lights will be restricted by personnel responsible for fire prevention and protection to areas designated as safe for those purposes.

b. **Waste disposal.** Rubbish, including waste paper, straw, excelsior, sweepings, and the like, will be placed in metal cans with covers, or in metal-lined bins with automatic or self-closing covers, and will be removed from buildings daily. Oily rags will be placed in standard metal cans with self-closing covers and with legs at least 4 inches high, to permit air circulation between the container and the floor.

c. **Storage.** Matches, lamps, and lamp fuels will be stored separately and in a safe manner.

d. **Building inspections.** Buildings will be inspected for fire hazards, including conditions pertaining to cleanliness, orderly and safe storage and handling of inflammable, combustible, or other hazardous materials, and to ascertain that electric wiring, electric equipment, heating units, chimneys, stovepipes, and steam pipes are arranged safely and are in good condition.

61. PILING MATERIAL. All grass and inflammable objects will be cleared from the ground where material is to be piled and for a distance of at least 6 feet around each pile. Creosoted material will be placed on the ground in stacks as small as practicable and not less than 50 feet apart. If conditions will not permit small piles and 50 feet of separation, leave open fire spaces of 30 feet at intervals of about 60 feet and provide necessary additional protection. Do not store creosoted material within 60 feet of timber structures.

62. FIRE PROTECTION EQUIPMENT. a. **Electric fires.** If it is feasible to do so, electric current will be cut off in circuits involved in or adjacent to a fire. Water will not be used to extinguish electric fires unless it has been ascertained that current supply to affected parts has been cut off. Sand and extinguishers containing vaporizing liquid (carbon tetrachloride base), carbon dioxide, or dry com-

pound will be used on fires in progress in or adjacent to live electric wires or equipment. Extinguishers containing vaporizing liquid should not be used in small inclosed spaces without adequate ventilation because of the danger of asphyxiation.

b. Water barrels. Where the use of water barrels is indicated in or at structures, one water barrel with three buckets will be considered a unit for the protection of each 2,000 square feet of floor space or fraction thereof. The tops of barrels will be protected by loose fitting covers, and barrels will be readily accessible. Buckets may be hung from the barrel by means of hooks or may be placed in a light crate located not more than 5 feet, and not less than 2 feet above the floor. In geographical locations where freezing weather may be expected, antifreeze ingredients such as granulated or flake 75 percent calcium chloride will be added to the water to insure against freezing at the lowest anticipated temperatures.

c. Extinguishers. Soda and acid extinguishers, pump tanks, and water type extinguishers using a gas cartridge as a propellant will be placed in buildings in accordance with the following schedule:

(1) In frame structures, a unit extinguisher for each 2,000 square feet of floor area, so located that a person will not be required to travel more than 50 feet to reach the necessary extinguisher.

(2) In fire resistive or sprinkler equipped structures, a unit extinguisher for each 2,500 square feet of floor area, so located that a person will not be required to travel more than 75 feet to reach the necessary extinguisher.

(3) Where special hazards or processes indicate the need for special types of portable fire protection equipment, foam, vaporizing liquid, or dry powder extinguisher units will be installed in sufficient numbers to provide proper protection, but in no instance will the area and distance limits as listed in (1) and (2) above be exceeded.

(4) In geographical location where freezing weather may be expected, extinguishers which are susceptible to freezing

will be protected in accordance with standard practices as outlined in applicable standards published by the National Board of Fire Underwriters or its equivalent.

d. **Standpipes and hose.** Where the use of this equipment is indicated, it will be installed in accordance with standard practice as outlined in any applicable Army Regulation or in accordance with the applicable standards published by the National Board of Fire Underwriters or its equivalent.

63. TIMBER TRESTLES AND DECKS. Timber trestles and timber decks of steel bridges will be equipped with water barrels and buckets according to the following standard:

a. **Two hundred feet or less.** On open and ballast deck timber trestles 28 feet and under in length, no barrels; over 28 feet and up to 100 feet, inclusive, one barrel buried in the ground at one end; over 100 feet and up to 200 feet, inclusive, one barrel buried in the ground at each end.

b. **Over 200 feet.** Open deck timber trestles over 200 feet in length will be protected by a barrel buried at each end and by an additional barrel placed on deck at each interval of approximately 126 feet. No additional barrels will be placed on the deck of ballast deck timber trestles over 200 feet long unless so ordered.

64. STEEL BRIDGES. Wooden deck steel bridges will be equipped with water barrels according to the following standards: 70 feet and under in length, no water barrels; over 70 feet and up to 126 feet, inclusive, one barrel at each end; over 252 feet, one barrel at each end with intermediate barrels at approximately 250-foot intervals.

65. INFLAMMABLE LIQUIDS. a. **Storage.** All receptacles for storing and dispensing gasoline, cleaning solvent, naphtha, benzine, kerosene, benzol, alcohol, or other materials having like or greater fire hazard, will be of a type approved for the contemplated usage and will be painted

red. Applicable standards published by the National Board of Fire Underwriters or equivalent will be followed. Other liquids will not be placed in containers painted red. Unless inflammable liquid storage tanks are buried underground at such depth that the top of the tank is below the level of the lowest floor or cellar of important adjacent buildings, they will be located at least 30 feet away from such buildings. Unless natural drainage is in a direction which will carry leakage away from important buildings, facilities, or storage, inflammable liquid tanks of 500 gallons or greater capacity will be surrounded by dikes or trenches of sufficient size to contain the entire contents of the tank. Whenever possible, drums of an inflammable liquid from which periodical supplies are drawn should be stored in the open. If this is not possible, storage should be in a detached building used for no other purpose.

b. Handling. When supply containers of inflammable liquids are stored inside of buildings, adequate ventilation, either natural or mechanical, will be provided to prevent the accumulation of inflammable vapors. Transfer of liquids from one container to another will be done by daylight whenever possible. If artificial light is needed, it should be electric, with lights protected by vaporproof globes and with all wiring and electric equipment of such type and so installed as to conform to the standards set forth in the National Electric Code, with particular reference to those sections which apply to the installation of electrical equipment in hazardous locations.

66. DEMOLITION. The destruction of equipment, supplies, and matériel will be carried out only on proper authority. Methods of demolition will be found in FM 5-25.

PART TWO
WAY AND STRUCTURES
CHAPTER 6
ROADBED DRAINAGE

67. GENERAL. A well-drained roadbed is essential to good track maintenance. It is of primary importance that drainage be given careful consideration at all places (fig. 8).

a. Adequacy. All bridge, culvert, and pipe openings will be inspected during and after heavy rains to make sure that they are adequate to carry off the water. If they are not large enough, special studies and recommendations will be made to determine the proper size.

b. Drift. Channels of streams on each side of the railroad will be inspected frequently and cleared of any brush, drift, or other removable obstacles which may interfere with the flow of water. Cross drains will be installed wherever necessary.

68. DITCHES. The following regulations will be observed to keep ditches open at all times so as to divert water from the track:

a. Maintenance. Ditches will be cleaned thoroughly and restored to full size before and after rainy periods. Injurious scouring will be controlled by cribbing with old ties, filling in with brush, large stone, or riprapping.

b. Construction. Side ditches will be dug uniformly, parallel with the track, and in conformance to standard roadbed sections. The ends of ditches will be diverted from the roadbed so that the action of water will not weaken or

wash away the embankment. To prevent water from coming over the top of a cut, surface ditches will be constructed to carry the water along the top and to drain it away from the roadbed at the end of the cut. Surface ditches will be located where they will not cause slides or be undermined by slides. Where practicable, a levee will be built between the ditch and the cut slope.

Square miles area drained	Acres	Water-way required	Square miles area drained	Acres	Water-way re-quired	Square miles area drained	Water-way required
0. 01	6. 4	2	0. 55	352	70	15	835
. 02	12. 8	4	. 60	384	74	20	970
. 03	19. 2	6	. 65	416	78	30	1180
. 04	25. 6	7. 5	. 70	448	81	40	1350
. 05	32. 0	9	. 75	480	85	50	1510
. 06	38. 4	10. 5	. 80	512	88		
. 07	44. 8	12	. 85	544	91		
. 08	51. 2	13. 5	. 90	576	94		
. 09	57. 6	15	. 95	608	97		
. 10	64. 0	16	1. 0	640	100		
. 15	96. 0	25	2. 0		200		
. 20	128.	32	3. 0		300		
. 25	160.	38	4. 0		388		
. 30	192.	44	5. 0		455		
. 35	224.	51	6. 0		509		
. 40	256.	56	7. 0		556		
. 45	288.	62	8. 0		601		
. 50	320.	66	9. 0		641		
			10. 0		679		

Figure 8. Dun's drainage tables.

69. DRAINS. Install pipe drains if open ditches are not adequate to drain the roadbed in areas where the ground is saturated with water from springs and water pockets. If necessary, extend lateral or cross drains into the center of the roadbed at sufficient intervals to insure drainage. Drain pipes will be located sufficiently far from the surface of the ground to prevent disturbance by frost or by movement of the subgrade.

70. **ROADBED MATERIAL.** a. **Disposition.** Material for widening the roadbed will be leveled immediately and lined to the uniform width and to the proper elevation below the bottom of the ties to avoid obstructing drainage. Material taken from ditches will be deposited over the side of adjacent embankments and leveled immediately. Never leave such material near the ends of ties or on sides of cuts.

b. **Borrow pit.** Borrow pits will be drained if practicable. A berm at least 10 feet wide will be left between the foot of an embankment and the edges of a ditch or borrow pit.

CHAPTER 7

TRACK

Section I. BALLAST

71. OBJECTIVES. The main objectives attained by the use of ballast are:

a. Drainage. To provide rapid and effective drainage.

b. Support. To hold the track firmly in position and to effect a uniform support for the track by distributing the weight of the traffic on the roadbed.

c. Surfacing. To provide material with which the track can be evenly surfaced.

72. TYPES AND USE. Ballast will be broken stone, slag, gravel, chats, or cinders. Embankments will be widened and track will be ballasted according to current instructions. (fig. 9).

Inches of ballast under tie	Track gauge				
	2' 6" and 3' 0"	3' 3" and 3' 3 ⁵ / ₈ "	3' 5 ³ / ₈ " and 3' 6"	4' 8 ¹ / ₂ " and 5' 0"	5' 3" and 5' 6"
4 -----	1, 391	1, 391	1, 468	1, 529	1, 605
5 -----	1, 619	1, 619	1, 708	1, 779	1, 868
6 -----	1, 849	1, 849	1, 951	2, 032	2, 134
7 -----	2, 088	2, 088	2, 203	2, 295	2, 410
8 -----	2, 345	2, 345	2, 473	2, 577	2, 706
9 -----	2, 605	2, 605	2, 748	2, 863	3, 006
10 -----	2, 855	2, 855	3, 011	3, 137	3, 294

Note.—20-inch tie spacing. Ballast dressed even with top of tie and slope 1:4.

Figure 9. Table shows cubic yards of ballast required per mile of track.

73. UNLOADING. Ballast will be distributed uniformly along track when being unloaded; this eliminates excessive rehandling of ballast.

74. PROTECTION. Open or unballasted track will be kept at a minimum, guarded carefully, and protected by the proper slow order. If necessary, loosen bolts at joints to avoid buckling rail and throwing track out of line.

75. BANKING. Embankments below grade or of less than standard width will be built up to standard roadbed requirements before new ballast is applied. In building up an embankment, first throw the old ballast from the sides into the center of the track, otherwise a fill at the sides on top of the old ballast will form a water pocket and cause the new bank to slip.

76. REMOVING MATERIAL. Before applying ballast, remove all unsuitable material down to the bottom of the ties; such material can be used to widen shoulders if necessary. Where heaving and wet spots develop, the bad material will be taken out to such depth and in such manner as to insure drainage; the space will then be filled with clean cinders, gravel, or broken stone.

77. DRAINAGE. When ballasted track becomes foul and pumps, the ballast will be cut away from the ends of the ties to a depth necessary to drain off the water; make the necessary repairs as soon as conditions permit.

78. LINING TRACK. Track will be thrown to general line before ballasting.

79. CLEANING. Stone ballast, so filled with cinders, dirt, or other undesirable material that it does not drain properly, will be cleaned with forks, screens, or other devices as directed by the maintenance of way superintendent. Unless the track is to be raised, cleaning will follow tie

renewals, and ballast will be kept dressed to the proper ballast section as work progresses. Before track is raised, ballast will be cleaned and thrown back into the track, so it will require a minimum amount of handling and spreading after new ballast is applied.

80. TIE RENEWALS. Tie renewals will be made while track is being raised; such renewals will be made after the ballast has been cleaned and before new ballast is applied.

81. CIRCUITED TRACK. In track circuited territory, any mud, dirt, or ballast (except clean stone) that may touch the rail will be removed to allow at least 1 inch between such material and the base of the rail. Proper slope for drainage will be preserved.

82. TAMPING. Ballast will be tamped according to the following instructions:

a. Tools. All ballast except cinders will be tamped with tamping picks or other approved devices except where it is being renewed in quantities requiring more than one raise. In such cases, tamping with shovels or forks will be permitted for the first raise.

b. Initial tamping. The first and most solid tamping will be under the rail bearing portions of ties and about 15 inches on each side of the rail for 8-foot ties and 18 inches on each side of the rail for 8-foot, 6-inch ties.

83. GAGING AND LINING TRACK. When ballasting is completed and dressed to standard section, track will be put to correct gage, surfaced, and lined.

Section II. TIES

84. INSPECTION. An inspection by a track supervisor or an inspector appointed for that purpose, will be made annually to determine which cross ties and switch ties will be renewed. The maintenance of way superintendent will

observe the inspection frequently and examine the report during the inspection. If renewals are extraordinary or if their necessity is not fully understood, he will make personal inspections.

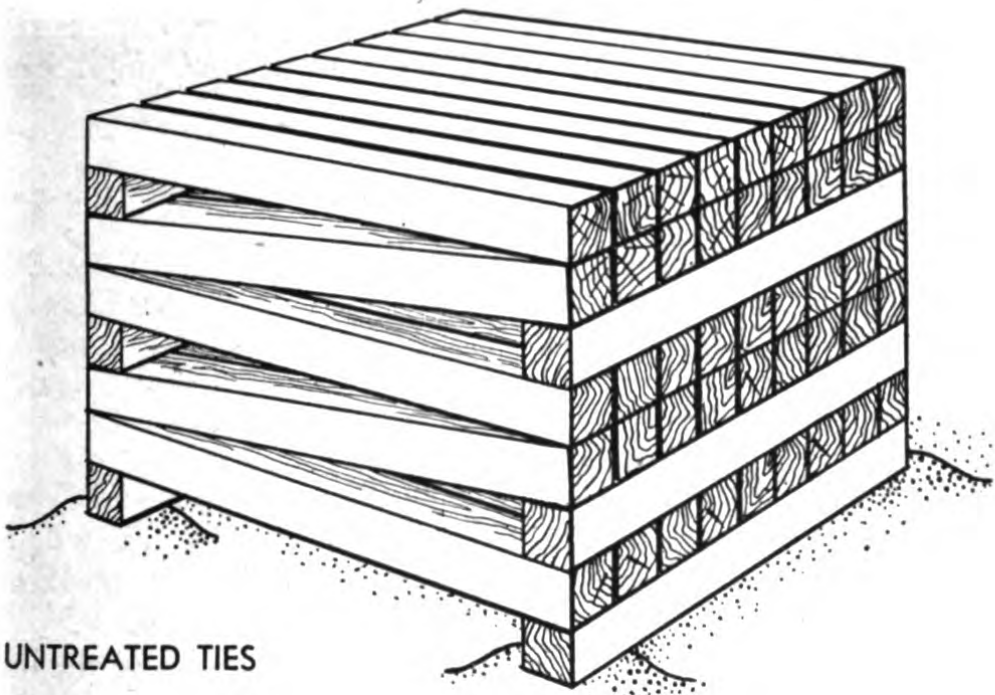
85. BASIS OF RENEWAL. Selection of ties for renewal will be based on careful examination of each tie, taking into consideration local roadbed conditions, the quality of ties on each side of the one under inspection, the amount and character of traffic, and the grade and alignment of track.

86. MARKING. A spot of white lead paint will be placed on the web of a rail above the tie to be removed. Such spotting will be on the outside rail on double track, and on the south or west rail on single track. On sidings, place the spot on the rail away from the main track.

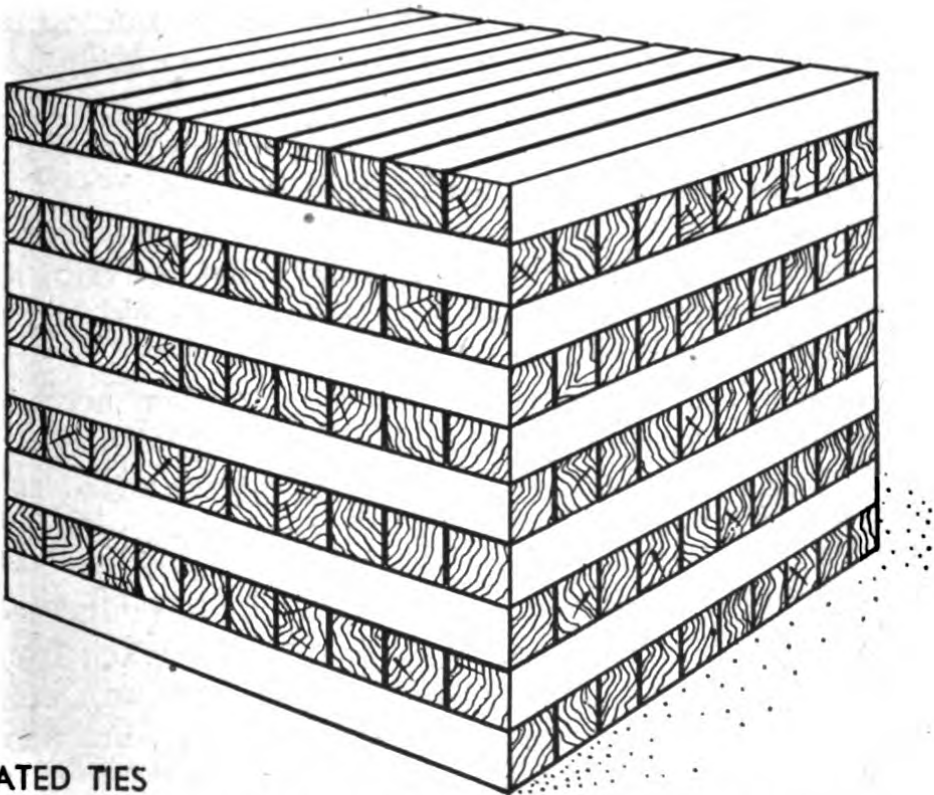
87. UNSPOTTED RENEWALS. Because ties may be examined in more detail when the track is open for surfacing and tie renewals, the foreman may renew an unspotted tie found to be unfit for service or leave in a tie that is spotted but is found suitable for further use. The total renewal for any 1 mile will not exceed the spotting unless authorized by the maintenance of way superintendent. Broken ties will be renewed immediately upon discovery.

88. DISTRIBUTION. The maintenance of way superintendent will arrange for the proper distribution of replacement ties as the inspection of each mile is completed and approved. New ties not required for immediate use will be piled in an orderly manner on dry ground (see fig. 10), at least 15 feet from the center of the track with approximately 75 ties in each pile. Ties will not be placed where they block ditches, culverts, or other waterways, or where they may be carried by flood.

89. HANDLING. Tie tongs will be used in handling ties either from cars or along the roadway; picks will not



UNTREATED TIES



TREATED TIES

Figure 10. Methods of piling untreated and treated ties.

be used for this purpose. When spacing ties, be careful to avoid damaging them by blows with a spike maul, pick, or other sharp tool.

90. SPACING. The following table will govern the spacing of ties:

	<i>Number of ties per—</i>		
	<i>30-foot rail</i>	<i>33-foot rail</i>	<i>39-foot rail</i>
Main tracks, running side tracks.....	16	18	22
Yard, side, and other tracks.....	14	16	20

91. INSTALLATION. **a. Selection.** Grades and classes of ties to be used in the different classes of track will be determined by special instructions. The largest and best ties will be used at joints.

b. Angle. Ties will be placed at right angles to the line of rail with the heart side of the lumber down.

c. Lining. Ties will be lined on the outside on double track, on the south or west side on single track, and on the high side of curves. The ends of 8-foot ties will be 18 inches from the web of the rail, and the ends of 8-foot, 6-inch ties will be 21 inches from the web.

d. Renewals. When renewing a tie in track that is not being raised, remove sufficient ballast from the cribs to permit extraction of the old tie; dress down the old bed so the new tie may be installed under the track.

e. Adzing. Ties will be adzed only when necessary to give the tie plates a uniform bearing; such adzing will be held to a minimum. Apply hot creosote to adzed surfaces of treated ties.

92. DISPOSAL AND SALVAGE. Remove and save tie plates, rail braces, and spikes when ties are taken from the track. Unless otherwise instructed, pile and burn defective removed ties daily according to the following directions:

a. Piling. Piles of not more than 40 ties will be placed 25 feet from the nearest rail and a safe distance from fences, telegraph poles, bridges, and buildings. Never locate

such piles beneath telephone, telegraph, or signal wires. If the narrowness of the right-of-way prevents placing piles the minimum required distance from the track, each pile will be limited to 10 ties.

b. Burning. Vegetation will be cleared away from tie piles far enough to keep fires from spreading. Ignite piles in the morning hours so that they will be under observation during the working day and to lessen danger of fires spreading at night. Such fires will be controlled and guarded, particularly if there is any danger to adjacent property.

Section III. RAIL

93. GENERAL MAINTENANCE. Rail will be maintained in safe condition at all times. Maintenance work will be supervised carefully and performed in compliance with the following instructions:

a. Inspection. Foremen will make frequent trips over their sections and watch for evidence of rail defects such as nicks, kinks, transverse and compound fissures, horizontal and vertical split heads, crushed heads, piped rails, split webs, broken bases, fillet cracks, and other damage (fig. 11).

b. Lubrication. Rail and rail fastenings, switches, and spring frogs will be lubricated according to standard instructions to prevent corrosion and frozen joints.

c. Joints. Joints will be fully bolted and kept at the prescribed tension. They will be examined frequently and cracked or broken joints will be replaced.

94. DEFECTIVE RAIL. If a defective rail cannot be removed and replaced promptly, foremen will have such a rail protected immediately with splice bars attached to span the damaged place. A bolt hole will be drilled through the middle of a defective rail when it is removed from the track, and such rail will not be used again in main track.

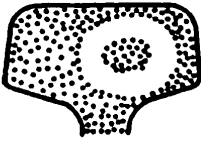


Fig. A
Transverse Fissure



Fig. B
Compound Fissure

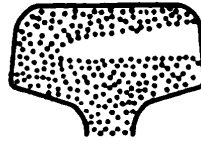


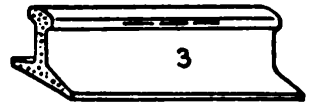
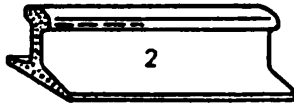
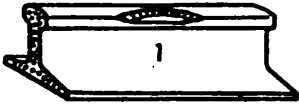
Fig. C
Horizontal Split Head



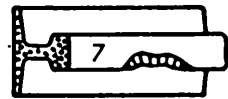
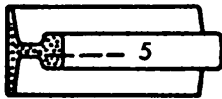
Fig. D
Vertical Split Head

Transverse Fissure—A crosswise break starting from a center or nucleus inside the head of the rail from which it spreads outward. The broken rail will show either a bright or dark, round or oval smooth area around the nucleus. See Fig. A.

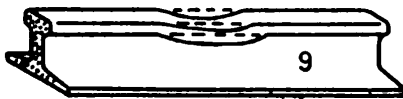
Compound Fissure—A horizontal split head which, in spreading turns up or down in the head of the rail. See Fig. B.



Horizontal Split Head—A horizontal break beginning inside the head of the rail and spreading outward; usually indicated on the side of the head by a lengthwise seam or crack, or by the flow of metal. See Fig. C and diag. 1, 2 and 3.

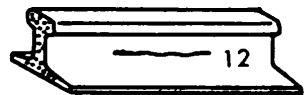
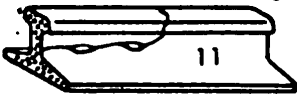


Vertical Split Head—A vertical split through or near the middle of the head, and extending into or through it. A crack or rust streak may show under the head close to the web or pieces may be split off the side of the head. See Fig. D and diagrams 4, 5, 6 and 7



Crushed Head—A flattening or crushing down of the head. See diagrams 8 and 9.

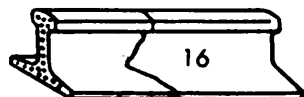
Piped Rail—One with vertical split, usually in web, due to failure of the shrinkage cavity in the ingot to unite in rolling. See diagram 10.



Split Web—A lengthwise crack along the side of the web and extending into or through it. See diagrams 11 and 12.



Broken Base—Any break in the base of a rail. See diagrams 13 and 14.



Square or Angular Break—Any partial or complete break in which there is no sign of a fissure, and in which none of the defects listed above can be seen. See diagrams 15 and 16.
Damaged Rail—Any rail broken or injured by wrecks, broken, flat, or unbalanced wheels, slipping or similar causes.

Figure 11. Description of track failures.

95. HANDLING AND DISTRIBUTION. a. **Unloading.** Skids or derricks will be used when unloading new rail.

b. **Distribution.** Rail will be distributed so that it can be laid with the least amount of handling. If a rail-laying machine is to be used, unload rail on both sides of the track. Rail for repairs will be kept on hand at convenient locations.

c. **Disposal.** Relieved rail which is not needed for immediate use will be piled neatly (fig. 12) at convenient locations. It will not be left between tracks in station limits where trainmen or other personnel walk.

96. CLASSIFICATION. Relieved rail will be classified by the track supervisor as follows:

a. **No. 1 rail.** Rail suitable for relaying in main track will receive this classification and the ends will be painted white. Curve-worn rail will not be classified as No. 1. Rail less than 24 feet in length will not be shipped to other divisions.

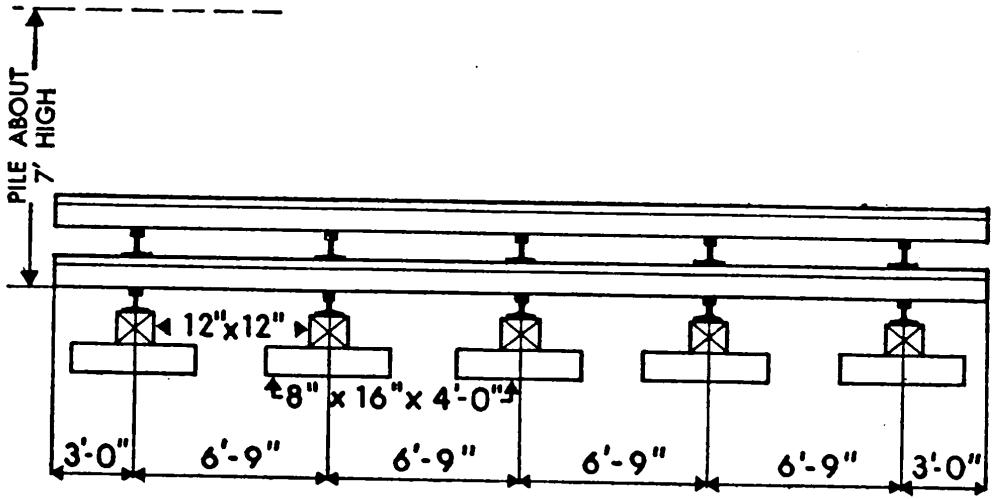
b. **No. 2 rail.** Rail suitable only for side track use will receive this classification and the ends will be painted green.

c. **Scrap.** Rail which cannot be classified as No. 1 or No. 2 will be classified as scrap. All rail from which 15 feet or more suitable for yard tracks cannot be cut, and all pieces under 11 feet in length of whatever quality, will be classified as scrap.

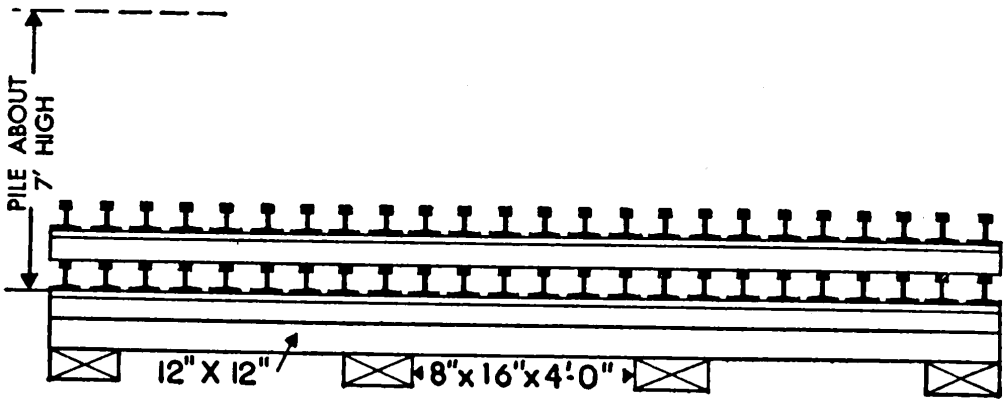
97. PREPARATION FOR RENEWAL. Before rail renewals are made, the following actions will be taken:

a. **Protection.** The supervisor of track will inform the maintenance of way superintendent of the location of work the day before rail is to be laid. If work is to take place in signal territory, the signal supervisor also will be notified. Foremen of rail-laying gangs will inform the train dispatcher of the location of the work each morning, arrange for necessary speed restricting orders, and obtain line-ups of trains as often as necessary to prevent delays to trains and work.

b. **Lining and surfacing.** The track will be lined and surfaced properly before rail renewals are made.



SIDE VIEW



END VIEW

Figure 12. Methods of piling surplus rail.

c. **Tie treatment.** After old rail is removed, the bearing surface of ties will be cleaned, spike stubs will be driven down at least $\frac{1}{2}$ inch below the surface of ties, and all spike holes will be plugged. Ties will then be adzed to an even surface; the adzed surfaces will be swept clean and swabbed with hot creosote.

98. LAYING RAIL, GENERAL. The following are general instructions for laying rail:

a. **Length.** Rails will be laid one at a time, and not in strings. Short rails may be used only on tangents and inside of curves. They may be used also in making temporary closures, connections with switches, driving up steel, and in connecting with rails of a different section. Under no circumstances will rails shorter than 14 feet be left in track permanently.

b. **Tie plates.** Tie plates and rail anchors will be applied at the same time rail is laid. Sufficient rail anchors will be used to keep the ends of rails in proper relation to each other if there is a tendency to rail creeping. Rail anchors will be applied as directed and will be kept bearing against ties. Never place rail anchors within a distance of three ties from a joint. Do not drive anchors along ties when making adjustments, but remove and reapply them.

c. **Joints.** Rail will be brought together against expansion shims and angle bars will be applied before rail is spiked into place. Unless otherwise instructed, lay rail with joints varying not more than 30 inches from the center of the opposite rail. Do not place joints in road crossings, opposite the center of water tanks and water columns, or near the ends of bridges; if these practices cannot be avoided, joints will be butt welded. Remove expansion shims after joint bar bolts are tightened and rail is spiked into place.

d. **Curves.** When renewing rail on curves sharper than 2° with rail of a different section, the new rail will always be extended around the curve before the end of the day's work.

99. EXPANSION SHIMS. The thickness of expansion shims between the ends of rails, as indicated in the following table, is governed by the temperature of the rail (temperature reading is obtained by placing a thermometer on the rail):

<i>Temperature</i>	<i>Thickness of shims</i>	
	<i>33-foot rails</i>	<i>39-foot rails</i>
0° to 25°	3/16 inch	1/4 inch
26° to 50°	1/8 inch	3/16 inch
51° to 75°	1/8 inch	1/8 inch
76° to 100°	1/16 inch	1/16 inch
Over 100°	None	None

100. JOINTS AND CONNECTIONS. a. Bolting.

All main track joints will be fully bolted at prescribed tension with the sloping side of the nut against a spring washer. If a rail joint is so tight that movement of rail within the joint is impossible, loosen the bolts, equalize the space, oil the joint, and retighten the bolts. Never cut holes through rail with a torch; use a drill.

b. Temporary connections. Do not use switch points to make temporary connections when laying rail. Connections to be left after working hours will be made by applying standard joint fastenings fully spiked and bolted.

c. Compromise joints. Compromise joints of approved pattern will be used to connect rail of different sections.

d. Open deck bridges. Only plain angle bars will be used on open deck bridges. Spikes will not be driven at the ends of angle bars.

101. GAGE. Tangents and curves of 8° or less will be gaged carefully to the standard of 4 feet 8 1/2 inches as rail is being laid. Use a gage at least at every fourth tie. On curves exceeding 8°, the gage will be widened 1/8 inch for each additional 2° to a maximum of 4 feet 9 inches. Widening caused by wear will not exceed 4 feet 9 inches on curves of 8° or less, and 4 feet 9 1/2 inches on sharper curves.

102. SPIKING. Rail will be fully spiked at all times unless another type of spiking is required in accordance with

specification given elsewhere in this paragraph. Spikes will engage the base of the rail fully and will be driven vertically; do not slant spikes under the rail or bend them against the rail. The last few blows of the maul should be given lightly to avoid straining or breaking the head of the spike, and to prevent striking the rail. Observe the following additional instructions:

a. **Full spiking.** Full spiking is the driving of one spike on each side of the rail base in every tie, staggering the spikes in position on each tie to act against rail creeping and tie slewing. Outside spikes always will be opposite each other, as will inside spikes.

b. **Double spiking.** Double spiking is the driving of an additional spike on the outside or inside of the rail.

c. **Location.** On single track, outside spikes will be ahead of those on the inside in the direction of creeping. Where there are two or more tracks, outside spikes will be ahead in the direction of traffic.

d. **Tie plates.** (1) Use two spikes with each tie plate on tangents and on curves of 2° or less.

(2) Drive two hold-down spikes and two spikes against the rail in each double-shoulder tie plate on curves of more than 2° .

(3) Drive four spikes with each tie plate on No. 10 turn-outs or any turn-out sharper than No. 10, and on curves of 7° or more.

(4) Drive two spikes on the inside and one spike on the outside in each tie plate in the following circumstances:

(a) On turn-outs lighter than No. 10.

(b) On curves over 2° and under 7° .

(c) On one entire rail ahead of each switch point.

Section IV. LINING AND SURFACING

103. **GENERAL.** The track will be level on all tangents except approaches to curves that are not spiraled. Special attention will be given to the line and surface of track at ends and approaches of bridges, through tunnels, switches,

and crossings, and at stations and other fixed structures. The ballasted surface of track will not be disturbed except on orders of the supervisor of track.

104. PROTECTIVE RUN-OFFS. Run-offs will be adequate to provide safe passage for trains when track is being raised and surfaced.

105. CLEARANCES. The surface of track will not be raised or lowered in tunnels, under overhead structures, or at ends of bridges or paved streets, except under instructions from the maintenance of way superintendent; instructions will be governed by established elevations and clearances.

106. LEVEL BOARD. The level board will be used constantly when surfacing track.

a. **Testing.** The level board will be tested for accuracy on receipt and at least every 3 months thereafter. Test by shimming under one end until the bubble is in the center of the tube, then turning the board end for end and putting it on the same supports. If the bubble goes to the center of the tube each time, the level is true; otherwise it is not true and will be adjusted.

b. **Spot board.** A spot board will be used when surfacing out of face. The height of the sight block and foresight strips will be checked carefully each time the board is reset.

107. TRACK GAGE. Track gages will be tested for accuracy on receipt and at least once each 6 months thereafter.

108. BUCKLING TRACK. Before disturbing the track, the foreman will, if necessary, adjust the amount of opening at joints. He will be governed also by any special instructions to prevent buckling of track.

109. JACKING. When raising track, place jacks in the crib ahead of a joint in order to avoid straining the joint.

Jacks will be set true to avoid disturbing the line, and will not be placed inside of rail, except where necessary, and then only under proper flag protection.

110. GAGE OF TRACK. Put the track to proper gage before lining it.

111. LINING. To take out the long swings at the first lining, the foreman or person designated to do the sighting will stand as far distant as he can see well, then will come up to within 60 to 90 feet for sighting and direct the gang over the track to remove short irregularities.

112. SUPERELEVATION AND RUN-OFF. The inner rail of a curve will be maintained at grade, and the proper curve superelevation (fig. 13) will be obtained by raising the outer rail. Superelevation will be given as the track supervisor directs, the amount to be governed by local conditions with reference to speed and grades. Observe the following additional regulations:

a. **Simple curve.** On a simple curve, full superelevation will be given throughout the entire length and the run-off will be made on tangents as indicated in figure 14.

b. **Spiraled curve.** On a spiraled curve, the track will be level at the point of spiral. The superelevation will be brought up regularly in the length of the spiral to full superelevation.

c. **Compound curve.** In a compound curve other than spiral, the full superelevation will be given the curve of greatest degree throughout its length; the superelevation then will be reduced as indicated in figure 14 until the proper superelevation is attained for the curve of lesser degree.

d. **Reverse curve.** On a reverse curve, the track will be made level at the point of reverse, and full superelevation will be obtained each way by raising the outer rail as indicated in figure 14.

Se = Speed at equilibrium elevation, in miles per hour.
 Sp = Speed at 3' unbalanced elevation, in miles per hour.

Curves	Elevations	1/4"	1/2"	3/4"	1"	1 1/4"	1 1/2"	1 3/4"	2"	2 1/4"	2 1/2"	2 3/4"	3"	3 1/4"	3 1/2"
0° 30'	Se	30	40	50	55	60	65	70	75	80	85	90	95	100	
	Sp	100		105	110										
1° 00'	Se	20	25	35		40	45	50	55		60	65	95	70	
	Sp	70		75		80		85			90				
1° 30'	Se			25	30	35		40	45		50	75	55		80
	Sp	55		60		65		70	70			45		50	
2° 00'	Se		20		25	30		35		40	65	45			70
	Sp	50			55			60		35		40			45
2° 30'	Se						30			35			60		45
	Sp	45		20		50		30	55					40	
3° 00'	Se					25			50		35		55		
	Sp	40			45					30					
3° 30'	Se						25			30			35		
	Sp			40				45					50		
4° 00'	Se				20			25			30			35	
	Sp	35				40					45				
4° 30'	Se											30			
	Sp			35							45	30			
5° 00'	Se					20			25				30		
	Sp				35					40				30	
5° 30'	Se						20			25				30	
	Sp						35								
6° 00'	Se						35						40		30
	Sp	30						20	35		25				40

7° 00'	{Se Sp				30		20			35		25	
8° 00'	{Se Sp	25		30		20					25		35
9° 00'	{Se Sp		25					20	30				
10° 00'	{Se Sp				25					20			
11° 00'	{Se Sp					25					30		
12° 00'	{Se Sp							25				20	30
							25						

Figure 13. Elevations and speeds for curves.

Se = Speed at equilibrium elevation, in miles per hour.
 Sp = Speed at 3'' unbalanced elevation, in miles per hour.

Curves	Elevations	3¾"	4"	4¼"	4½"	4¾"	5"	5¼"	5½"	5¾"	6"	6¼"	6½"	6¾"	7"
0° 30'	{ Se	105	110												
	{ Sp														
1° 00'	{ Se	75		80		85			90		95			100	
	{ Sp	100		105			110								
1° 30'	{ Se	60		65			70			75	95		80		100
	{ Sp			85			90								
2° 00'	{ Se		55			60			65				70		
	{ Sp			75			55		80		60				
2° 30'	{ Se		65					70							
	{ Sp		45				50				55				
3° 00'	{ Se								65					70	
	{ Sp			60						50					
3° 30'	{ Se					45				60					
	{ Sp		55						45					50	
4° 00'	{ Se														
	{ Sp			40			55								
4° 30'	{ Se														
	{ Sp					50									
5° 00'	{ Se		35					40			45				
	{ Sp							50			55				
5° 30'	{ Se									40					
	{ Sp			35				50			50				
6° 00'	{ Se														
	{ Sp						35					40			50
	{ Se						45								
	{ Sp														

7° 00'	{Se										35												45	
	{Sp																						35	
8° 00'	{Se							30																
	{Sp																							
9° 00'	{Se				25																			
	{Sp						35																	40
10° 00'	{Se						25																	
	{Sp												35											
11° 00'	{Se																							30
	{Sp																							
12° 00'	{Se									25														
	{Sp																							35

Figure 13. Elevations and speeds for curves—Continued.

Elevation (inches)	Miles per hour																	
	10	15	20	25	30	35	40	45	50	55	60	65	70	75	80	85	90	
	Length of run-offs (feet)																	
1	10	18	25	30	35	40	45	53	60	65	70	75	80	88	95	100	105	
1½	15	27	38	45	53	60	68	80	90	98	105	113	120	132	143	150	158	
2	20	35	50	60	70	80	90	106	120	130	140	150	160	175	190	200	210	
2½	25	44	63	75	88	100	113	131	150	163	175	188	200	220	238	250	263	
3	30	53	75	90	105	120	135	158	180	195	210	225	240	263	285	300	315	
3½	35	62	88	105	123	140	158	185	210	228	245	263	280	308	333	350	368	
4	40	70	100	120	140	160	180	210	240	260	280	300	320	350	380	400	420	
4½	45	79	113	135	158	180	203	236	270	293	315	338	360	396	428	450	473	
5	50	88	125	150	175	200	225	263	300	325	350	375	400	438	475	500	525	
5½	55	96	138	165	193	220	248	289	330	358	385	413	440	482	523	550	578	
6	60	105	150	180	210	240	270	315	360	390	420	450	480	525	570	600	630	

Figure 14. Table of run-offs, standard gage.

113. NONSTANDARD RUN-OFF. If the tangent between curves is too short to provide for a standard length run-off, proceed as follows:

a. Division of tangent. Divide the tangent into two parts in proportion to the degree of curves which it connects, the greater part being next to the curve of the greater degree. Make the track level at the division point.

b. Constructing run-off. Bring the run-off up each way from the division point as indicated in figure 14, using as much of the curves as necessary for that purpose.

114. DEGREE OF CURVE. To determine the degree of any curve, use a line 62 feet long with a knot at the middle; stretch line on the gage side of the outer rail, selecting a well lined portion of the curve. Measure the distance from the knot to the gage side of the rail. Each inch of this distance will indicate 1° of curvature. For example, if the distance is 4 inches, it is a 4° curve.

115. TRACK SHIMS. In surfacing track, the use of track shims will be avoided where possible, but in no case will ties be adzed to compensate for heaving. If action of mud or frost makes it necessary to shim the track, the shims will be placed on top of ties in accordance with the following instructions:

a. Specifications. Shims will be of the same thickness throughout, not wedge-shaped. Those more than $\frac{1}{2}$ -inch thick will be at least 8 inches in length.

b. Spiking. If shims more than $\frac{3}{4}$ -inch thick are used, holes will be bored in them and extra-length spikes will be used. When such shims are removed, extra-length spikes will be saved and kept in the toolhouse for future use.

c. Rail braces. Shims $\frac{1}{2}$ -inch or more thick on a straight track, and all shims on curved track, will be accompanied by a fully spiked rail brace to prevent the track from spreading or turning.

d. Tie plates. Shims used where the track is tie plated will be placed beneath tie plates, never on top of them.

e. **Removal.** Shims will be removed from track as early as possible in the spring and before surfacing or ballasting. Ties will be tamped to solid bearing.

Section V. TURN-OUTS

116. **LOCATION.** Turn-outs should not be located on curves. On track where traffic is in one direction, turn-outs will not face in the direction of traffic if it can be avoided.

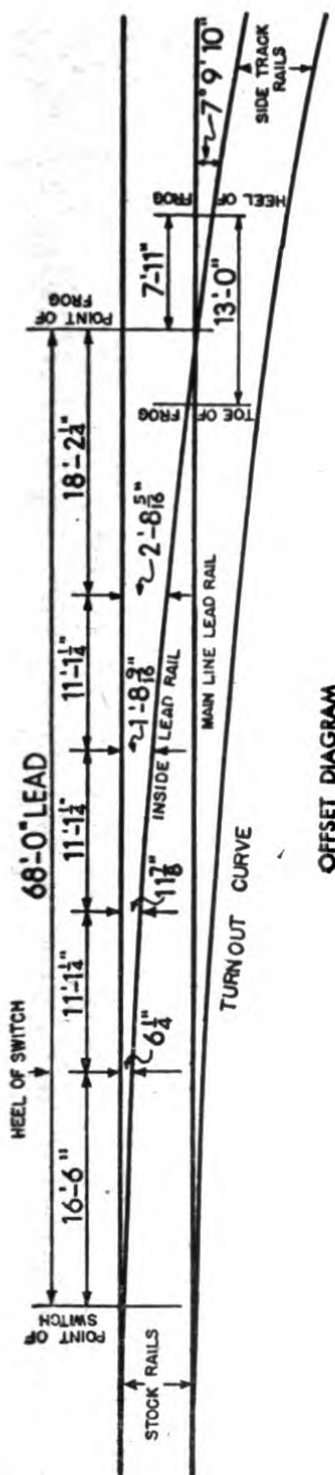
117. **INSTALLING.** Turn-outs will be installed and maintained according to standard plans and special instructions (fig. 15). The following general procedure will be practiced:

a. **Preparation.** In preparing to install a turn-out, first locate the point of switch and the point of frog. Then remove main track rails, if necessary, and replace them with rails of such lengths that joints in the main line will not fall between the point and the heel of the switch, or between the ends of guard rails. Clean the ballast from between the ties to the bottom of the ties for the entire length to be occupied by switch ties.

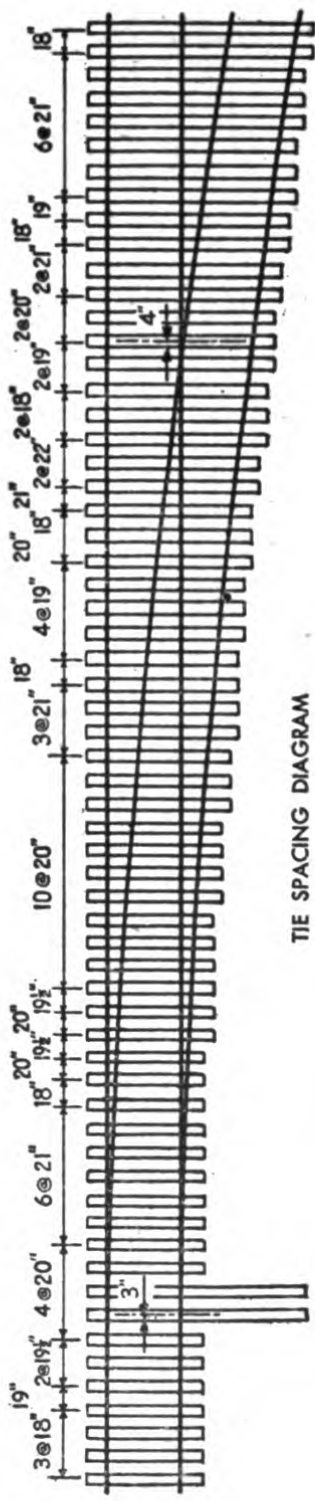
b. **Ties.** Pull all spikes from every other cross tie, jack the track up sufficiently and remove the loose cross ties; install switch ties of the proper length. Pull spikes and remove the remaining cross ties; install switch ties, being careful to space them according to standard plan. Tamp all new ties their entire length.

c. **Frog.** Remove the rail where the frog is to be located, set the frog in place, make connection to main line rail, and spike the frog to gage.

d. **Inside guard rail.** Install a guard rail (see fig. 16) in the main line opposite the frog so that the guard rail provides a flangeway of $1\frac{3}{4}$ inches. Guard rails will be of the same section as the turn-out, will conform to standard plan, and will be placed so that the gage side of the frog will be 4 feet $6\frac{5}{8}$ inches from the flange side of the guard rail. When the gage is widened for curvature, the distance



OFFSET DIAGRAM



TIE SPACING DIAGRAM

BILL OF TIMBER			
55 PCS.			
TOTAL			
9 PC	8'-6"	3 PC	11'-0"
6 PC	9'-0"	3 PC	11'-6"
4 PC	9'-6"	2 PC	12'-0"
4 PC	10'-0"	3 PC	12'-6"
4 PC	10'-6"	3 PC	13'-0"
		2 PC	13'-6"
		2 PC	14'-0"
		3 PC	14'-6"
		3 PC	15'-0"
		4 PC	15'-6"

Figure 15. Number 8 turnout, standard gage.

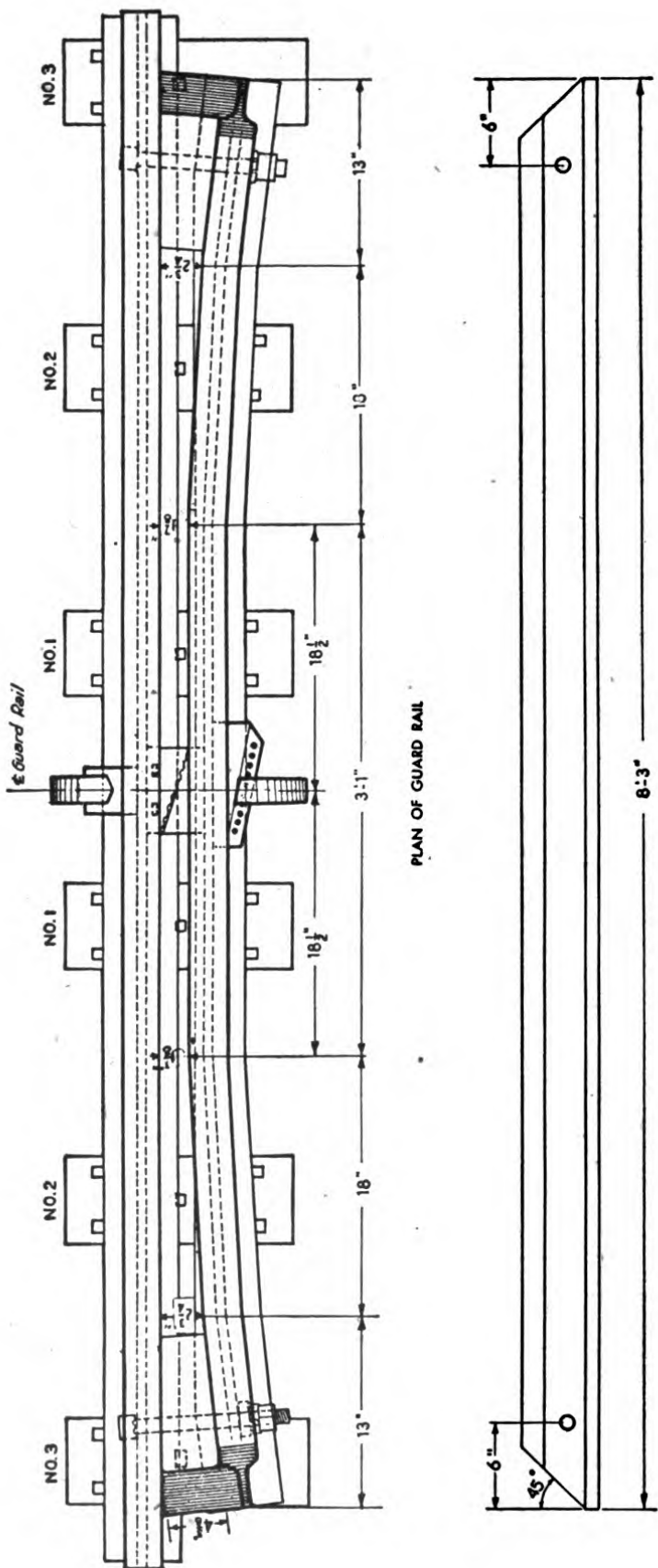


Figure 16. Details of a guard rail installation.

between the guard rail and the running rail will be increased in proportion.

e. Lead rail and switch points. Assemble the inside lead rails, join them to the frog and switch point, and spike the rails at the heel of the switch point, allowing $6\frac{1}{4}$ inches clearance between the heads of the rails. If the proper heel plates are used, this opening will be correct when the rails are spiked through the slot holes in the heel plate. Spike the inside lead rail to line. Line out the old main line rail, set in main track lead rails, and make connections with the frog and switch point. Bend the stock rail with a rail bender to produce a slight kink $8\frac{1}{4}$ to 10 inches ahead of the switch point, and place the switch point against the stock rail. Install slide plates on the head blocks and spike the stock rail and switch point to gage. Line the side track rail to the proper gage distance from the inside lead rail and install the remainder of the slide plates and rail braces.

f. Switch stand. Set the switch stand in position on the head blocks, preferably on the turn-out side of the main line. Connect the stand to the connecting rod and the switch head rod. Open the switch points so that they are equal in distance from the gage of the stock and running rails. Make sure that the stand is parallel with the main line, and spike it down to the head blocks. Adjust the head and back rods so that each point will fit against the rails when the switch is thrown and will provide a throw of $4\frac{3}{4}$ inches. Insert the connecting rod bolt from below to permit ready inspection of the nut; always insert a cotter key or provide a safety cuff or block to prevent the bolt from dropping out.

g. Outside guard rail. When the side track rail has been laid beyond the frog, install the guard rail (see fig. 16) opposite the point of frog, providing a flangeway of $1\frac{3}{4}$ inches. It is important that the gage fit exactly from the point of frog to the side track rail.

Section VI. SWITCHES, FROGS, AND DERAILS

118. GENERAL. Trackmen will inspect and maintain switches, frogs, and derails according to standards and prac-

tices detailed in this section. Safety blocking will be maintained at frogs and guard rails in accordance with standard plans. Where track connecting to main track is out of service for long periods of time, frogs, guard rails, switch points, and lead rails will be taken up and the main track restored to good condition.

119. SWITCHES. **a. Points.** In making an inspection of switches, pay particular attention to line, gage, and wear of switch points. Points will fit closely and accurately to the stock rail, which will be kinked in accordance with the standard set forth in paragraph 117e. All bolts will be tight and equipped with the necessary cotter keys. Slide plates equipped with standard braces will be kept in good condition and will be well lubricated. Heel joints will be secure and maintained properly.

b. Stock rail. When a switch point is renewed, the stock rail will also be renewed, if necessary, to secure a proper fit of the point.

c. Throw. Switches will be thrown during inspections to see that there is no lost motion and that the standard throw of $4\frac{3}{4}$ inches is maintained.

d. Stands. Check the general condition of the switch stand, of the vertical staff bolt, collar rivet and lock, the position of head block straps and the goose neck key.

e. Lock. If a switch lock is found to be defective, the switch will be secured properly and a new lock provided as soon as possible.

f. Signal territory. When inspecting switches in signal territory, examine the rod and fastenings which connect the switch point to the switch box to determine that the rod is not bent, that the switch foot is securely bolted to the point rail and is not bent or broken, and that all cotter keys and jamb nuts are in place. Defective rods or connections will be repaired or reworked to the signal mechanic promptly.

120. SWITCH LIGHTS. Switch lights will be maintained on main track, siding, and yard track switches.

Lights are not required on main track switches provided with reflector units or protected by an automatic block system, including locomotive cab signals and automatic stop, or on any other switches exempted by the proper authority. If for any reason a light cannot be maintained on a switch, the foreman will notify the supervisor of track and the train dispatcher so that proper notice will be given trains. Observe the following maintenance instructions:

a. Wicks. Lights will be adjusted until the wicks are at the height to give the best light possible. Wicks should not be trimmed by cutting, but by rubbing the end to remove the burned crust.

b. Filling. Avoid filling lamps to full capacity; the oil may expand and overflow onto the switch target. Also avoid discoloring targets by touching them with greasy hands.

121. FROGS. During inspection observe closely the wear and general condition of frogs. Gage at the point will be tested on both the main line and turn-out side. Bolts will be kept tight, footguards will be kept in place, and spring bolts will be maintained in good condition and at proper tension. Hold-down devices will be maintained in good condition and be well lubricated, and the spring wing rail will be kept working freely.

122. DERAILS. The main track will be protected by derails in all connecting tracks except passing sidings as follows:

a. Location. Derails will be located so that derailed cars will clear the main line.

b. Locking. Derails will be kept set and locked for derailment at all times except when the track is in use. Failure to leave derails locked in proper position will be reported to the supervisor of track and the trainmaster, giving, if possible, the number of the train or locomotive last using the track.

Section VII. SIGNAL TERRITORY

123. PROTECTION. Maintenance personnel will avoid damaging signal apparatus. If any damage occurs, notify the signal mechanic promptly and make repairs if practicable. During work near an interlocked or remotely controlled switch, make sure that personnel do not place their hands or any tools or material between the switch point and the stock rail until arrangements have been made with the signal operator and the switch point is blocked. Observe the following regulations:

a. Flagging. When it is necessary to obstruct track within interlocking or block signal limits, observe flagging rules and do not depend upon a signal operator or fixed signals to stop trains.

b. Notification. Signal mechanics will be notified in advance when work is to be done which will in any way affect the operation of interlockings, block signals, crossing bells, or any other signals.

124. GENERAL MAINTENANCE. **a. Drainage.** Adequate drainage for all signal apparatus will be provided and maintained.

b. Cleaning. Accumulations of dirt or cinders will be removed from between and under the rails, around pipe and wire connections within interlocking, block signal, and crossing signal limits. Vegetation will be cut away from interlocking towers, trunking leads, block signals, crossing signals, relay and battery housings, pipe and wire lines, and all connections around interlockings. Pipe lines, connections, derails, and switches will be kept free of ice and snow during storms. Mechanics and signal operators will be assisted by track or bridge maintenance personnel in keeping interlocking plants clean and in operation.

c. Gages. Only insulated track gages will be used within track circuit limits.

125. INSULATED JOINTS. Maintenance personnel will follow special instructions issued for the proper in-

stallation and maintenance of each type of insulated joint. Maintain such joints at fouling points on side tracks in the same general condition as those in main track. Rail ends will be square and will not lip or flow so as to bridge across the fiber end posts. One fiber end post will be used at each joint, and the ends of the rail will be laid and maintained tight against the post. Assemble joints properly and apply them to the rail with perfect fit and insulation. Observe the following additional instructions:

a. **Ties.** Maintain good supporting ties and the proper tie spacing, line, and surface.

b. **Bolts.** Install a complete set of bolts in each joint and keep them tight.

c. **End posts, fiber plates.** Keep end posts and fiber plates in place; renew them when they are worn out or broken.

126. BOND WIRES. Cut off bond wires on broken rail before removing the rail; after the rail is renewed, notify the train dispatcher, signal mechanic, and track supervisor.

127. TRACK CIRCUITS. Only insulated slide or gage plates, switch, head, or bridle rods will be installed inside track circuits limits. Do not install connecting tie plates under lead rails or main rails at points back of the first pair of insulated fouling joints on turn-outs. Rail braces will be located in such a manner that they will not interfere with track circuits or detector bars.

CHAPTER 8

STRUCTURES

Section I. BRIDGES, BUILDINGS, CULVERTS

128. STANDARDS. Bridges, buildings, and culverts will be maintained in conformance to standard plans and instructions. Additions will conform in construction and appearance to main buildings to which they are attached. Bridges and other structures of less than standard overhead clearance will be protected by warning signals.

129. GENERAL INSPECTION AND MAINTENANCE. Inspections of bridges and trestles will be made periodically to detect defects as they develop so that accidents may be prevented and repairs made with maximum economy. Inspections will follow general instructions and specific instructions for the type of structure concerned. The following are general instructions for the inspection of all bridges and trestles:

a. Notes. Write inspection notes for each structure at the structure, and record notes in bridge record (WD AGO Form 55-254).

b. Effect of trains. Note the effect of passing trains, reporting any undue deflection, sway, or twisting of the bridge as a whole or in any of its parts.

c. Line and surface. Give close attention to the line and surface of track on bridges and approaches; report the presence and cause of poor line and surface.

d. Renewals. Mark decayed, split, or broken ties and guard rails for renewals.

e. Guard rails. Make sure that track and inner guard

rails are fully spiked and bolted and that timber guard rails are in correct line and are bolted tightly.

f. Water barrels. Determine whether required water barrels are present and whether they are filled with water.

g. Drift. Note whether there is drift against bents or piers; make arrangements for its removal if it is objectionable.

130. WOODEN BRIDGES AND TRESTLES. The following are instructions for the inspection and maintenance of wooden bridges and trestles:

a. Timbers. Examine the condition of all timbers in all members, sounding them with a hammer or boring inspection holes if necessary. Bore inspection holes upward at a slight angle so they will drain, and plug them with treated pegs. Make sure that all bolts are tight; report any bents that are not plumb. Examine posts and piling at the top, at the sills, and at the ground line. Give particular attention to that portion of the caps immediately over piles and to that portion of stringers resting on caps.

b. Helper post. Place a helper post alongside any pile having 6 inches or less of sound timber. If more than two such piles occur in one bent, drive new piles or cut off the original ones and erect a frame bent upon them. Piles will be cut off no farther below the ground than necessary to reach sound timber.

c. Fire hazard. Remove birds' nests and other materials which create a fire hazard.

131. STEEL BRIDGES. The following are instructions for inspection and general maintenance of steel bridges:

a. Routine. Follow a fixed routine, examining all parts in order so that no part will be overlooked.

b. Track embankments. Start the inspection by observing the line and surface on the bridge and on the embankment. Note the condition of the embankments at bridge ends because banks are frequently narrow at these points.

c. Masonry. Examine all masonry carefully, inspecting as much of it on the ground as possible.

d. Soundings. Take soundings in front of abutments and around piers to determine whether there has been any change in the bed of the stream which might cause failure or settlement of the masonry.

e. Anchor bolts. Examine the condition of anchor bolts, noting any missing or bent bolts or nuts and the condition of the masonry plate or casting.

f. Expansion rollers. Determine whether expansion rollers are in proper position for existing temperatures.

g. Compression members. Give particular attention to the straightness of compression members, showing on a sketch any loose or bent hangers, bottom chords, or diagonal bars. Especially note and report the action of such members during passage of trains.

h. Adjustable members. Make sure adjustable members, such as counters and lateral rods, are just tight enough to insure initial tension when there is no train on the span.

i. Condition of steel. Check steel below the track for deterioration from brine drippings and that above the track for deterioration from locomotive blast and gases.

j. Loose rivets or bolts. Slotted pin holes and any loose rivets or bolts will be reported promptly and the conditions corrected.

k. Dirt, debris. Remove or report any accumulation of dirt or debris around steel.

132. MOVABLE BRIDGES. The following instructions will be observed in the inspection and maintenance of movable bridges.

a. Open draw. Examine the raising or turning gear carefully; open the draw occasionally under the direction of the supervisor of bridges and buildings.

b. Passage of trains. Make sure that wedges have full bearing when the draw is in position for trains to pass. Observe carefully the action of the draw during the passage of trains, noting whether the ends rise or pound.

c. **Mechanism.** Make sure the bridge mechanism is kept clean and in good condition, and that all lubricated parts are free of dirt and grit. Gears, wheels, and wedge bearings will be kept well lubricated.

133. CULVERTS. Note the soundness of timbers in culverts and examine pipe or masonry for cracks. Measure corrugated iron pipes vertically and horizontally to determine whether there is any flattening. Check the condition of paving and drainage surrounding culverts, watching for scour holes on the downstream end; such holes usually indicate too small an opening.

134. PILES AND TIMBERS. a. **Penetration.** Proper penetration will be obtained when driving piles. If piles are too long or too short, or driving conditions are unsatisfactory, a report will be made immediately to the supervisor of bridges.

b. **Creosoting.** Creosoted piles and timbers will be swabbed with hot creosote when cut or adzed.

135. PROTECTION. a. **Completion of work.** Except in emergencies, each piece of work will be completed before another is started. Unfinished work will be kept safe for the passage of trains and personnel.

b. **Avoiding delay.** Work will be handled by conferring with the train dispatcher, when practicable, so as to delay trains as little as possible. Attention will be given signals which trains carry so that following sections will not be delayed unnecessarily.

c. **Scaffolding.** Foremen in charge of work which requires scaffolding will personally inspect tackle and all material to insure that such equipment is safe. They will supervise the safe construction of scaffolding and see that it is not overloaded.

d. **Storm, fire damage.** If storm, fire, enemy action, or other damage endangers or prevents the passage of trains, foremen will take measures at once to protect trains and to

repair the damage. They will notify promptly the bridge and building supervisor, the maintenance of way superintendent, and the train dispatcher.

136. SCRAP DISPOSAL. Worthless material from bridges or trestles undergoing repairs will be burned at a sufficient distance from the structures to insure safety. All fires will be extinguished before work is stopped. Scrap metal will be disposed of according to instructions.

137. SALVAGE. Sound material removed from bridges, trestles, or buildings, and surplus bolts, washers, and other metal parts will be piled conveniently on the ground above ordinary high water line for shipment.

Section II. TUNNELS

138. GENERAL. Restrictions of light and space and the regular operation of trains through tunnels impose difficult conditions for maintenance and inspection of roadbed, track, drainage, and lining of all types of railroad tunnels. Proper maintenance, however, requires inspections at regular specified intervals.

a. Personnel selection. It is important that track gangs and other personnel involved in the maintenance and relining of tunnels be selected carefully and trained on the basis of ability and experience.

b. Lighting and inspection car. Adequate equipment for lighting and an inspection car to be equipped with suitable scaffold and a platform with safety railing will be provided for making thorough inspections of tunnels.

c. Track. Track will be inspected frequently to insure proper maintenance, especially if inadequate drainage is causing water pockets and soft spots. Unusual problems are presented because ballast is fouled by the accumulation of locomotive cinders and of dirt falling from cars or carried into the bore by air currents set up by moving trains. Cross ties are difficult to remove and replace because limited clear-

ance prevents raising track. Frequent renewals of rail and of track fastenings are necessitated because of rapid corrosion promoted by the chemical reaction of metal to locomotive gases.

139. UNLINED TUNNELS. Inspection and maintenance of unlined tunnels requires particular attention to loose or scaling rock. Removal of such rock is an important phase of maintenance; intervals between scaling operations will be governed by experience with and knowledge of rock formations. If work is not extensive, scaling will be accomplished with bars and wedges. Paving breakers will be used for extensive operations and to obviate the necessity for blasting. Explosives, even in small quantities, will be used only as a last resort.

140. TIMBER-LINED TUNNELS. Timber-lined tunnels will be inspected to detect decay or cracks, particularly at the foundation of posts and under the wall plates. Posts will be replaced if they show signs of decay or cracking which will impair their strength. Arch rings will be inspected to discover any distortion or cracks; if such conditions are found, additional arch rings will be placed.

141. CONCRETE- OR BRICK-LINED TUNNELS. Properly constructed concrete- or brick-lined tunnels require comparatively little maintenance, but inspections will be made at specified intervals. Direct blast and gases from locomotives often cause disintegration of the concrete lining, especially near the ends of the bores. Brick-lined tunnels, especially old ones, present similar problems in disintegration of mortar joints. Such joints require careful inspection, and the arch will be sounded to discover any loose bricks. Slight damage in both brick- and concrete-lined tunnels can be repaired with shotcrete, but advanced disintegration will necessitate relining damaged portions.

Section III. CROSSINGS, SIGNS, FENCES

142. CROSSINGS. Highway and farm crossings, and approaches thereto, will conform to standard plans and meet requirements of the law and the following regulations:

a. Maintenance. Crossings and approaches will be maintained in the best possible condition. Particular attention will be given to make sure that flangeways are kept clean in freezing weather and that guard rails and planks are not forced above the top of the main rails.

b. Clear view. Trees and other vegetation will be cut or removed if they obstruct the view of enginemen and travelers. If such growth is on private property it will be cut or removed only with permission of the owner. Material will not be piled so that it obstructs the view.

c. Signs. Unless otherwise provided by law, all public highway crossings will be provided with standard highway crossing signs.

d. Protection. Work on public streets, highway crossings, and highway bridges will be performed with the least possible inconvenience to the public and safeguarded in compliance with the law. If it is necessary to construct temporary foot or driveways, they will be maintained in safe condition.

143. SIGNS. All sign and signal posts will be maintained plumb and in good condition, with the following regulations observed:

a. Mile posts. Mile posts will be placed 10 feet from the center of the track and on the right-hand side of the track facing south or west. In cuts the posts may be placed 15 feet from the center of the track to avoid blocking drainage.

b. Whistling posts. Whistling posts will be placed at distances required by law in both directions from all public highway crossings at grade and stations; posts will be on the engineman's side 10 feet from the center of the track. In cuts these posts may be placed 15 feet from the center of the track to avoid blocking drainage.

c. **Crossing signs.** Crossing signs will be visible on highways for a distance of at least 100 feet on each side of the crossing. Signs should be placed 15 feet from the center of the track.

144. FENCES. Immediate repairs will be made to defective railroad fences. Gaps in landowners' fences will be temporarily closed to keep stock off of right-of-way and landowners will be notified so that they may make permanent repairs.

Section IV. SCALES

145. RESPONSIBILITY. A scale inspector appointed and instructed in his duties by the maintenance of way superintendent will be responsible for inspecting, cleaning, and maintaining scales.

146. CLEANING. The platform, scale parts, superstructure, and foundation will be cleaned at least once each month for wagon or depot scales, and at least twice each month for track scales. Scales exposed to weather or otherwise located so that they may become clogged with dirt or ice will be cleaned as often as necessary. Use artificial heat to thaw ice obstructing scale parts; never use salt.

147. MAINTENANCE. Both scale and approach tracks will be maintained in good line and surface with an open joint of $\frac{1}{2}$ to $\frac{3}{4}$ inch between approach rails and scale rails. Keep weighing beams on all scales balanced and working freely. When not in use, beams will be kept locked with beam catches. Paint scales and metal parts of the superstructure when they are installed and as frequently thereafter as necessary, using standard bridge paint.

148. OPERATION. Track scales will be used only for weighing; equipment not being weighed will not be allowed to stand on scales. Use the "dead" rail when it is

necessary to pass over the scale locomotives or other equipment not to be weighed. Cars will not be bumped off scales with a locomotive or another car on the "dead" rail, nor will they be pulled across the scale when they are coupled to another car moving on the dead rail. Enginemen will not use sand on the rails of scales or operate the injector when locomotive is standing on or passing over scales.

149. **SECURITY.** Keep doors and windows of scale houses locked when scales are not in use. If there is no scale house, keep the beam housing locked when the beam is not in use.

Section V. TURNABLES

150. **GENERAL MAINTENANCE.** a. **Inspection.** Turntables will be inspected at regular intervals to insure proper maintenance and operation.

b. **Repairs.** After making repairs, turntables will be tested under load to make sure they are operating properly. Make repairs with the least possible delay.

c. **Cleaning and lubrication.** Steelwork, decks, pits, and machinery will be kept clean of accumulations of cinders, dirt, and rubbish; machinery will be lubricated and adjusted properly. It is essential that end truck axle bearings be lubricated regularly and that center pivot bearings be kept full of mineral oil to the overflow level. Ice and snow will be cleared from pits; drains and catch basins will be kept clean and open. Fire, salt, or any corroding compounds will not be used for thawing near or on turntables.

d. **Painting.** Painting will be done according to instructions and as required.

151. **CENTER PIVOT BEARING.** Center pivot bearings of turntables at important locations will be opened in the spring and fall, washed with kerosene, inspected, and, if necessary, repaired. After kerosene has been removed bear-

ings will be refilled with lubricant, gear, universal, grade 90 (SAE 90). At less important locations, bearings will be given the same attention at least once each year.

152. ROLLER BEARING HOUSING. Roller bearing housings of three-point support turntables will be given maintenance and lubrication attention annually. They will be emptied of oil and flushed with kerosene; caps will be removed for inspection, and housings will be refilled to the proper level with lubricant, gear, universal, grade 90 (SAE 90), after all kerosene has been removed from bearing boxes. Oil pumped out by longitudinal motion will be replaced at regular intervals. Examine nuts regularly and keep them tight.

153. CIRCLE RAIL. The circle rail will be maintained in good condition, with foundations and anchorages adequate to keep the rail in correct alignment vertically and radially.

154. APPROACH TRACK. Approach track rails will be maintained with the tops level with the tops of rails on the turntable. Gaps between the ends of the approach rails and those on the turntable will not exceed one-half an inch. Worn or battered rails will be replaced or built up by welding.

Section VI. WATER SUPPLY FACILITIES

155. GENERAL. All water-supply facilities, including wells, pipe lines, pumps, tanks, buildings, water columns, and boilers will be maintained in good condition. Wells will be cased when necessary. Pipe lines will be laid below the frost line where practicable.

156. PUMPS. Pumping engines will be given frequent attention and maintained according to standard for the type of unit. Particular attention will be paid to the packing

and lubrication of all parts of pumps and engines. If there is danger of freezing, boilers, pipes, and pumps will be drained; cooling systems of internal combustion engines will be drained or protected with an antifreezing mixture. Buildings housing internal combustion engines will be well ventilated to protect personnel from gases and to reduce fire hazard.

157. BOILERS. Gage cocks and water glasses of boilers will be kept clean and in good condition. If muddy water is used, boilers will be blown down daily, filling them first and then blowing them to one gage with not more than 30 pounds of steam. Boilers will be washed and cleaned at least once each week, and oftener if the water supply engineer or technician deems it necessary. Hole plates will be removed and cinders and rust scraped carefully from the firebox. Flues will be cleaned and ashes and soot removed from the front end.

158. TANKS. Wooden tanks will be kept full to prevent shrinkage of staves, but overflow will be avoided. Tanks containing turbid water will be cleaned at least annually and oftener if conditions require; tanks containing filtered or clear water will be cleaned as often as necessary. Cleaning will be done at times when traffic will not be delayed.

159. COLUMNS. Water columns will be maintained in good condition with automatic locks holding them parallel with track. They will be swung in the direction of traffic on double track when practicable. Spout and grab ropes will be maintained at standard clearance. The spout sheave and chain will be lubricated at least once a month to insure free movement of the spout.

Section VII. PAINTING

160. GENERAL. Effective painting is based on three requirements—proper preparation of surface to be painted, the

use of paint of good quality, and careful application of paint. (See TM 9-2851.)

a. Preparation. Surface will be cleaned of dirt, oil, grease, scale, or corrosion, using methods specified for the particular surface to be treated. Make sure the surface is dry before applying paint.

b. Paint. Standard paint of proper specification for the kind of job and surface will be used.

c. Application. Paint will be applied uniformly with brushes or spray guns during favorable weather. Each coat will be thoroughly dry before another coat is applied.

161. STEEL BRIDGES AND STRUCTURES. Steel bridges and other structures should be painted before the old paint film breaks. The addition of one or two new coats to the original paint will protect steel adequately and eliminate excessive cleaning later.

a. Preparation. If necessary, steel will be cleaned down to the bare metal. Three field methods of cleaning steel are in general use—scraping or chipping with hand tools, steel brushes, or pneumatic tools; sand blasting; and burning with blow torch. Sand blasting usually is the most thorough method, but requires special equipment. Effective repainting schedules will eliminate the necessity of sand blasting.

b. Application. Structures should be cleaned and painted by sections, the painting following the cleaning on the same day, if possible.

162. WOODEN STRUCTURES. **a. Preparation.** Exterior surfaces usually are cleaned by using steel scrapers to remove loose, scaling paint. Edges of cleaned areas will be dressed and the remainder of the surface brushed with steel brushes, sandpapered, or otherwise cleaned and dusted. Badly soiled spots, especially on interior surfaces, will be washed with a strong solution of washing powder or soap and then rinsed with clean water. Methods of removing old paint include scraping, burning with blow torches, and softening with varnish remover, concentrated lye, or caustic soda.

b. Application. Exterior surfaces will not be painted during damp or freezing weather.

163. PLASTER, BRICK, AND CONCRETE. Plaster, brick, or concrete surfaces will be cleaned thoroughly with brushes to remove loose material.

164. STENCILING AND LETTERING. Illegible or damaged stenciling or lettering will be retouched or replaced in its original form.

PART THREE
DUTIES OF PERSONNEL
CHAPTER 9
COMMISSIONED PERSONNEL

165. SUPERINTENDENT, MAINTENANCE OF WAY. The maintenance of way company commander is the superintendent, maintenance of way, and is responsible to the division superintendent or assistant division superintendent. He has charge of and is responsible for all engineering pertaining to maintenance of way and supervises maintenance of track, roadbed, bridges, buildings, fences and other structures, water supply, and signals and communications; makes frequent inspections to see that his organization is meeting proper standards of maintenance; approves and checks all requisitions for material, and is responsible that sufficient emergency stock is maintained on the division. He is responsible for military administration of his company and for rendition of military and railway reports. His territorial limits are the same as those of the division superintendent.

166. TRACK SUPERVISOR. Track supervisor reports to and receives instructions from the superintendent, maintenance of way. He assigns territorial limits to track maintenance sections and prescribes their duties. He examines track maintenance sergeants and corporals, track section foremen, to see that they are conversant with all rules and special instructions of the maintenance of way department and such rules of other departments as are required in the

proper performance of their duties. He holds track maintenance sergeants responsible for discipline, training men of their sections, and for railroad property within their territories. He is responsible for advance ordering of sufficient track material to insure rapid repairs, and for surplus material in his territory. In case of train accident, line obstruction, or damage, he proceeds at once to the site with forces, tools, and materials at his command. He clears the track and makes temporary repairs to permit passage of trains. Permanent repairs are made as soon as conditions permit. He takes charge of all section hands who report for duty. He is responsible for care and messing of his men and defense of the line unless this defense is delegated to other troops. His detailed duties include:

a. Inspections. Track supervisor inspects all main track rail twice each year. In addition, he makes other inspection trips frequently to observe the condition of track and roadbed, to determine that all culverts and drains are open, to make sure that everything likely to obstruct the track is removed, and that all other measures necessary to prevent accidents and delays to trains are taken. He also:

(1) Walks sufficient track at intervals to insure covering the entire division once a year and frequently rides over all main track on passenger and freight locomotives, preferably of fast trains.

(2) Inspects all main track switches once each month, recording the date and conditions found, and arranging for any repairs or adjustments.

(3) Inspects every main track curve at least once each month, recording the date and conditions found, and arranging for any needed repairs and adjustments. Instructs foremen concerning the proper elevation for each curve on their sections.

(4) Examines all ties in track at a designated time to ascertain the number of cross ties requiring renewal on each mile and the number of cross ties and switch ties requiring renewal on each siding for the ensuing year. Reports such figures as directed.

(5) Makes sure that track gages and level boards are tested in accordance with current regulations.

(6) Investigates the service of track material, tools, and equipment, and requires foremen and others in charge to make records of service given.

b. Property. Track supervisor knows all property lines on his division and prevents encroachments. He also:

(1) Knows the ownership and the division of maintenance costs of all industrial and connecting tracks. When maintenance work is performed, he makes sure that foremen make necessary renewals, repairs, and reports that correctly apportion the labor and material used.

(2) Keeps careful, complete records of cultivation permits and arranges for vacation or renewal at the proper time.

(3) Is responsible for the clean, orderly appearance of all right of way, station houses and grounds, and other property in his charge.

c. Rail classification. Track supervisor classifies and marks all rail relieved on his division in accordance with current regulations.

d. Accidents. Track supervisor proceeds immediately to the point of any accident and takes charge of all trackmen. In such cases, freight is handled carefully and initials and numbers of damaged cars are noted and reported to the maintenance of way superintendent. Supervisor makes sure that section foremen submit complete reports of accidents on proper form (WD AGO Form 55-213), and he sends these reports and his own to the superintendent, maintenance of way.

167. SUPERVISOR, BRIDGES AND BUILDINGS.

The supervisor of bridges and buildings reports to the superintendent, maintenance of way, to whom he is responsible for safety and adequacy of structures. He supervises work of his platoon and furnishes it with proper material and tools. He is responsible for maintenance of emergency supplies of bridge material to replace structures washed out, burned out, or destroyed. He aids the track

supervisor, if necessary, in opening the line for traffic after damage. He supervises maintenance of water supply facilities, fueling stations, and stationary boilers in stations and buildings except shops. He is responsible for messing and care of his men. His detailed duties include:

a. Plans. Supervisor makes sure that new buildings and additions to buildings are authorized and conform to standard plans. He makes sure that foremen are provided with and follow plans and instructions for repairing bridges.

b. Inspections. Supervisor inspects all bridges, culverts, snow sheds and tunnels at least once each 6 months, and all buildings, fences, water stations, and fueling stations at least once each year, reporting such inspections on WD AGO Form 55-253. Bridge Inspection Report, to the superintendent, maintenance of way. He accompanies the MRS headquarters bridge inspector on at least one inspection each year, and he makes any other inspections necessary to keep himself informed of the condition of bridges and buildings. Inspections are made in accordance with instructions in chapter 8.

c. Flood protection. During periods of flood and heavy run-off, the supervisor informs himself as to the character and volume of drift to be passed under important bridges, and makes sure that adequate forces and equipment are assigned to clear drift and prevent damage to structures or track.

d. Fire protection. Supervisor is responsible for the condition of fire protection apparatus for bridges and buildings (except shops) and familiarizes himself with fire protection rules. He instructs station agents and others in charge of buildings in the use of all fire-fighting appliances and equipment, and reports in writing all fires, regardless of whether a loss occurs.

CHAPTER 10

NONCOMMISSIONED PERSONNEL

Section I. SECTION FOREMAN

168. DEFINITION. The term "section foreman" is applied to the sergeant who commands a track maintenance section and to the corporal who assists him. The duties detailed in this chapter apply to the track maintenance section (sergeant) commander.

169. COMMAND. Section foreman is responsible for discipline and training of his men and supervises their work. Normally he has administrative and disciplinary control of all personnel assigned to permanent duty within his area. He commands track maintenance personnel.

170. GENERAL DUTIES. Section foreman reports to the track supervisor; is responsible for the maintenance of track, roadbed, and right of way of the territory allocated to him. He goes over rail lines of his area or sends a reliable track walker with suitable tools at least once each day to make thorough inspections and to see that track, highway crossings, bridges, culverts, fences, signals, etc., are in safe condition. He is responsible for tools and materials assigned to him and for timely requests for additional tools. He supervises the excavation and grading of right of way and the laying, and surfacing of track; is responsible for proper drainages, curvatures, grades, and clearances; supervises installation of switches.

171. INSPECTIONS. Except when track walkers are used, and unless otherwise instructed, section foreman passes entirely over his track section each day, observing the con-

dition of the main track, switches, sidings, culverts, and wire lines. Sees that culverts and other openings in roadway for passage of water are free of obstructions. Inspects main track rail at least once each month. During thaws, after heavy rains, and otherwise as necessary, inspects cuts for loose rock or sliding earth and removes any such material that might fall on the track.

a. Equipment. Provides track walkers with proper flagging equipment and necessary work tools.

b. Rail lubricators. Inspects rail lubricators at sufficient intervals to insure that they are maintained properly, supplied with lubricant, and are functioning.

c. Crossings and wyes. Makes frequent inspections of track crossings, wyes, and other such tracks, including all mine and industrial lines maintained by other interests or railroads on which his system's trains or locomotives are operated. Gives particular attention to clearances affecting safety of personnel. Notifies personnel maintaining such tracks of defects and any work required.

d. Steelwork. Keeps dirt clear from the ends of steel bridges and all steelwork, and from the tops of piers and abutments.

e. Drainage. Keeps all track, signal apparatus, platforms, and station grounds well drained.

172. SUPERVISION. Section foreman remains with his personnel, directing all work and engaging therein when the gangs are small. In emergencies a foreman is authorized to call on adjoining foremen for assistance, which will be rendered promptly. If called from duty in emergencies, the foreman leaves the most reliable man in authority with instructions to do no work which would obstruct the track until the track maintenance sergeant arranges for a substitute. Foreman should neither give nor lend his keys to anyone other than a substitute foreman.

173. SIGNALS. **a. Responsibility.** Section foreman is held jointly responsible with signal mechanics and signal

operators for the safe condition of switches and derails at interlockings. Towermen are instructed to operate switches or derails at the request of foreman to permit inspections when such operations will not interfere with the movement of trains. Any failure or unwillingness to do so will be reported.

b. Violations. Section foreman reports to the track supervisor and train dispatcher any nonobservance of signals by a locomotive or train crew, stating the date, time, locomotive, and signal number. He also reports any engineman who uses sand through interlocking limits or on spring switches, or allows water to run on their movable parts.

c. Failures or defects. Section foreman reports to the track supervisor and the train dispatcher any failure of block signals, giving the date, time, and signal number; reports improper operation of crossing protection apparatus promptly to a signal mechanic and the track supervisor. If apparatus does not indicate for an approaching train, foreman stations a watchman at crossing until repairs are made and the signal is functioning properly.

174. WEATHER PRECAUTIONS. Section foreman takes every precaution to prevent accidents during heavy rains and storms, observing the following instructions:

a. Track guard. Section foreman stays on duty and has sufficient personnel with him to insure safety of trains, especially to guard against washouts. Makes sure personnel watching track have signal equipment necessary to stop trains.

b. Drift. Inspects culverts and drains and makes sure all drift material is removed from them. Notifies supervisor and summons help from the nearest bridge section if drift at bridges is too heavy to handle. Makes sure drift is removed after floods recede.

c. Water mark. Provides reference point for engineers by marking high water line on an abutment or by driving an old spike as a marker where it will not be disturbed.

175. CLEARING OBSTRUCTIONS. Section foreman clears track in case of accidents or track obstructions. If a serious accident or obstruction requires additional forces or material, foreman reports immediately by the quickest and most reliable means available to the train dispatcher and supervisor, giving a statement of material, equipment, and labor necessary to make repairs. In addition, he takes the following action:

a. Investigation. Endeavors to ascertain the cause of an accident or obstruction as soon as practicable after arrival at the scene, preserving all evidence relating thereto.

b. Security. Stations guard to protect freight or railroad property against theft or loss from other cause.

176. SECURITY. a. Fire protection. Section foreman has the following responsibilities to protect track and structures from fire:

(1) Keep water barrels filled and put in sufficient salt each fall to prevent freezing. Report any unserviceable or missing barrels to the supervisor.

(2) Remove combustible material, and sod when necessary, from beneath trestles, around sign posts, telegraph poles, and other wooden structures, and from around piles of ties, timber, and piling. Give special protection to creosoted material.

(3) Cut right-of-way by machine or by hand in the vicinity of bridges. Clear track of grass for a distance of 50 feet from ends of all wooden deck bridges.

(4) Burn cuttings and trash at least 150 feet from any wooden structure after an adequate fire gap has been cleared between the structure and the rubbish.

(5) Provide suitable fire guards if they are needed to protect adjoining property.

b. Theft or loss. Section foreman is responsible for loose property such as ties, lumber, and scrap iron, and makes sure that it is not lost or stolen. Takes or sends to the nearest station agent any freight or packages that fall from passing trains.

177. COMPLAINTS. Section foreman keeps on friendly terms with land owners, tenants, and other citizens, listening to complaints and reporting such complaints and the circumstances to proper authority.

178. SIGNS. Section foreman permits only authorized signs on fences or structures on right-of-way and in station grounds.

179. POLICING. Section foreman makes sure station grounds, tracks, and right-of-way are kept in a clean, orderly condition. Reports promptly if any ash pans and front ends of locomotives are cleaned at frogs and switches, within interlocking plants, upon any ballasted track, or in yards (except at designated places) giving the date, train, and locomotive number.

180. BALLAST DISTURBANCE. If disturbance of ballast indicates a locomotive blowoff muffler is not adjusted properly, section foreman reports it to the supervisor, giving the date and locomotive or train number, if possible.

Section II. CONSTRUCTION FOREMAN, BRIDGES AND BUILDINGS

181. GENERAL. Staff sergeant, in charge of the bridge and building section, is construction foreman; he supervises work of the section and is responsible for discipline and care of his men. He makes sure that materials are delivered promptly so that there will be no delay in completing work. When section is separated from company mess he makes sure that arrangements are made for messing. Supervises and is responsible for the maintenance of bridges, culverts, snow sheds, buildings, tunnels, signs and fences. Reports to the supervisor of bridges and buildings.

182. INSPECTIONS. Construction foreman inspects bridges, culverts, buildings, tunnels, snow sheds, and fences

every 30 days, or as often as required, and reports on WD AGO Form 55-253 (Bridge Inspection Report). He makes inspections according to general instructions and specific instructions for the type of structure concerned as detailed in chapter 8 of this manual.

183. PROTECTION. In case of storms, fires, or other conditions which may cause damage to structures, foreman will observe the following instructions:

a. **Emergencies.** Goes on duty during storms and, when possible, remains at a communication point. Ascertains whether structures are being damaged, and takes all necessary safety precautions, including immediate measures to stop trains; takes steps to repair damage by storm, fire, or enemy action which may endanger or prevent the passage of trains. Notifies promptly the supervisor of bridges and buildings, and the train dispatcher of any condition that may affect the safe operation of trains.

b. **Traffic delay.** Performs work after conferring with the train dispatcher, when practicable, so as to delay trains as little as possible. Gives attention to signals which trains carry so that following sections will not be delayed unnecessarily.

184. PERSONNEL PROTECTION. Foreman instructs personnel in safety rules and makes sure that such rules are observed. Makes sure that no dangerous working conditions exist and that no dangerous practices are followed.

185. CLEARING DRIFT. Foreman arranges to clear bridges of heavy drift that cannot be handled by track maintenance sections. Makes sure cables or other attachments are not fastened to any member of a span except when the method of attachment is approved by supervisor of bridges and buildings.

186. ACCIDENTS OR FAILURES. Foreman reports in writing all accidents to or failures of any structures under

his charge, giving the date and cause. If repairs detain trains, he reports the day and hour when traffic was stopped and time it was resumed, stating the cause of detention.

Section III. WATER SUPPLY ENGINEER

187. GENERAL. Staff sergeant, water supply engineer, analyzes water by simple tests, determines the quantity available, and recommends such changes as may be in the interest of more efficient service. Reports to the bridge and building supervisor. Maintains water installations in cooperation with bridge and building sections.

188. FUEL AND SUPPLY. Engineer makes sure that all water stations are equipped properly with fuel, tools, and supplies, and that emergency stocks are on hand. Makes sure fuel is stored properly and protected from loss by fire or theft.

189. INSPECTIONS AND REPORTS. Engineer makes semiannual inspections of water plants, reporting in writing the condition of each and the date any repairs will be needed. Examines statements for water procured and checks meters frequently, with utility meter readers if possible. Checks all waste, reporting or correcting any defects or failures. Reports monthly concerning water consumption and details of operation for each water station.

190. SAFEGUARDING OPERATIONS. Engineer notifies promptly the superintendent, maintenance of way, and train dispatcher when a water station is out of service and when it again is ready for service.

Section IV. WATER SUPPLY TECHNICIAN

191. GENERAL. Water supply technician, grade 4 or 5, maintains and operates water supply stations; maintains pipe lines and related mechanical facilities; operates and

maintains water purification equipment; performs standard tests at regular intervals; cleans and washes sand filters; keeps required records and makes reports to the water supply engineer.

192. EQUIPMENT. Technician is responsible for the care and use of tools, material, and equipment necessary for performance of his work. Informs the engineer of materials needed well in advance of time of need.

193. AVAILABILITY. Technician leaves information at a designated place upon beginning each day's work to enable the water supply engineer or train dispatcher to locate him readily.

194. FIRE PRECAUTIONS. Technician is responsible for the maintenance of fire protection facilities exclusive of fire extinguishers, water barrels and buckets, and any equipment at terminals where fire protection is the responsibility of maintenance of equipment personnel. Keeps pump houses free of combustible waste material.

195. TRAIN PROTECTION. Before taking out of operation, either temporarily or permanently, any water tank, water column, or other facility affecting the water supply or operations, technician notifies the water supply engineer and train dispatcher. In an emergency, he may report a change after it has been made, using the most reliable means available. He gives proper notice when the facility is restored to service.

196. MAINTENANCE. Technician makes authorized repairs to machinery, pipe lines, and tanks, checking water columns once a week to lubricate them, tighten nuts on lifting rods, adjust any leaking packing glands, and set up spring cocks. Pays particular attention to the packing and lubrication of all parts of pumps and engines.

197. INSPECTIONS, REPORTS. Technician makes frequent inspections to guard against accidents and mechanical failures, and reports monthly or as required as follows:

a. Equipment. The general condition of machinery and tanks, including any defects in the spouts, valves, discharge pipes, or other facilities that cannot be repaired.

b. Fuel consumption. The number of hours a pump operated, and the amount of fuel used at pumping station during the month.

c. Fuel supply. The length of time the supply of fuel will last, and the amount and kind of fuel delivered, giving the date, initial and number of car, shipper's name, and point of origin.

APPENDIX I

DEFINITIONS OF TERMS

Alignment. The horizontal location of a railroad with reference to curves and tangents.

Angle or joint bar. A splice bar used as a joint fastening.

Anti-creeper or rail anchor. A device to prevent the creeping or movement of rail in track under traffic.

Ballast. Selected material placed on the roadbed for the purpose of holding the track in line and surface.

Brace, rail. A device used at switches, movable point frogs, etc., in combination with switch, tie or gage plates for holding the rail in place.

Car, hand. A four-wheeled, hand-operated railroad work car for transporting men and tools.

Car, motor. A motor-driven railroad work or inspection car.

Car, push. A four-wheeled railroad work car designed to be pushed by hand.

Car, trailer. A four-wheeled railroad work car, similar to a push car, designed to be attached to a motor car.

Center of tracks. The distance, measured at right angles, between the centers of parallel tracks.

Closure rails (lead rails). The rails connecting the heel of the switch with the toe end of the frog.

Compromise joint. A special rail joint used for connecting rails of different sections; so made as to bring the gage sides and the joined heads into line, and to support them so that continuous smooth surfaces are presented.

Cross-over. Two turn-outs with the track between their frogs, arranged to form a continuous passage between two nearby and generally parallel tracks.

Curve, degree of. The angle subtended at the center of a simple curve by a 100-foot chord.

Curve, compound. A continuous change of alignment by means of two or more simple curves of different degrees, having a common direction at their junction points.

Curve, easement. A curve whose degree varies either uniformly or in a definite manner so as to give a gradual transition between a tangent and a simple curve which it connects or between two simple curves.

Curve, reverse. Two contiguous simple curves in opposite directions with a common direction at their junction points.

Curve, simple. A continuous change in direction of alignment by means of an arc of a single radius.

Curve, vertical. A vertical curve in the track to connect intersecting grade lines. It provides smoother, safer passage of equipment.

Derail. A track safety device designed to guide railroad rolling stock off the rails at a selected spot as a means of protection against collisions or other accidents.

Easer rail. A rail placed with its head along the outside and close up to the head of the running rail and sloped at the ends to provide a bearing for the overhanging portion of the hollowed out treads of worn wheels.

Elevation (of curves). The vertical distance that the outer rail on curves is raised above the inner rail, sometimes called superelevation. It is required to resist the centrifugal force of the moving train.

Expansion shim. A spacer inserted between the ends of abutting rails while track is being laid to provide allowance for the expansion of the steel due to changes in temperature.

Fishing space. The space between the head and base of a rail occupied by the splice bar.

Flangeway. The space between the running rail and a guard rail which provides clearance for the passage of wheel flanges.

Frog. A device used where two running rails intersect and providing flangeways to permit wheel on either rail to cross the other.

Frog angle. The angle formed by the intersecting gage lines of a frog.

Frog number. One-half of the cotangent of one-half the frog angle, or the number of units of center line length in which the spread is one unit.

Frog point. The part of a frog lying between the gage lines extending from their intersection to the heel end.

Frog, rigid. See Stiff frog.

*Frog, spring.** A frog having a movable wing rail held against the point rail by springs, presenting an unbroken running surface to wheels using the main track, while the flanges of the wheels on the other track force the wing rail away from the point rail to provide a flangeway.

Fusee. A signaling device which when lighted and placed on the track burns with a red light, warning trains of danger.

Gage. A tool by which the gage of track is determined

Gage line. A line $\frac{3}{8}$ inch below the running surface of a rail on the side of the head nearest the center of the track.

*To determine whether a spring frog is right-hand or left-hand, stand at the toe end of the frog and look toward the point. The right-hand frog has the spring wing rail on the right-hand side and the left-hand frog has the spring wing rail on the left-hand side.

Gage of track. The distance between the heads of the rails measured at right angles thereto at a point $\frac{3}{8}$ inch below the top of the rail.

Gaging (of track). The bringing of the two rails into their correct relative position as regards the gage.

Grade. The ratio of rise or fall of the grade line to its length.

Guard rail. A rail laid parallel to the running rails of a track to prevent wheels from being derailed or to hold the wheels in proper alignment to the track to prevent their flanges from striking the points of switches or the points of frogs in turn-outs or crossings.

Guard rail brace. A metal shape to fit the contour of the side of the guard rail and extending over the ties and fastened thereto to prevent moving or tilting of the guard rail away from the running rail.

Guard rail clamp. A device consisting of a yoke and fastening devices engaging the running rail and guard rail to hold them rigidly in relation to each other.

Guard timber. A longitudinal timber placed outside the track rail on bridges to maintain the spacing of the ties.

Head block (switch). A tie or ties of a set used to support the switch point mechanism. Modern types of switch stands require the use of two head block ties.

Head rod. The switch rod nearest the point of the switch. It is usually placed between the two head block ties and extended beyond the turn-out rails, being fastened to the connecting rod of the switch stand.

Heel block (switch). A block which spans the joints and fills the space between the adjacent rails at the heel of the switch. It is joined with the outside splice bars by means of continuous bolts to form a unit joint, and it also serves as a foot guard.

Heel end of frog. The end of the frog farthest from the switch.

Heel length. The distance between the heel end and the half-inch point of the frog measured along the gage line.

Heel of switch. The end of a switch rail farthest from the point of switch.

Heel spread (frog). The distance between the gage lines at the heel end of the frog.

Heel spread (switch). The distance between the gage lines at the heel of the switch rails. This distance is $6\frac{3}{4}$ inches.

Insulated rail joint. A rail joint designed to arrest the flow of electrical current from rail to rail, as at the end of a track circuit, by means of non-conductors so placed as to separate the rail ends and other metal parts.

Insulated switch. A switch in which the fixtures, principally the gage plates and the switch rods connecting one rail to the other, are provided with insulation so that the electric currents will not be shunted.

Interlocking. An arrangement of switch, lock and signal appliances so interconnected that their movements succeed each other in a predetermined order. It may be operated manually or automatically.

Joint bar. A steel angle bar or other shape used to fasten together the ends of contiguous rails in a railway track. They are used in pairs, are designed to fit on each side of the rail between the head and the base of the rail and are held in position by means of track bolts.

Joint bar drilling. The provision of suitable holes at the ends of a rail, switch, frog or other track member to receive the joint bar bolts.

Lead, actual. The length between the actual point of switch and the half-inch point of frog, measured on the line of the parent track. It varies according to the number and the toe length of the frog and other details of the switch used.

Lead, curve. The curve in the turnout interposed between the heel of the switch and the toe of the frog.

Lead, theoretical. The distance from the theoretical point of a uniform turnout curve to the theoretical point of the frog, measured on the line of the parent track. It is seldom used other than in sharp turnouts in certain special track work.

Level. The condition of the track in which the elevation of the rails is transversely equal. A variation of no more than $\frac{3}{8}$ inch, if continuous, is permitted.

Line The condition of track in regard to uniformity in direction over short distances on tangents, or uniformity in variation in direction on curves over short distances.

Lining track. Shifting the track laterally to conform to the established alignment.

Main track. The running track of a railroad whereon the movement of trains is controlled by timetable, train order, or block signal.

Parent track. A track from which a turn-out is constructed. A main track is the parent track as regards a passing track; a ladder track is the parent track as regards the yard tracks.

Passing track. A track auxiliary to the main track for meeting or passing trains.

Point of switch, actual. The point where the spread between the gage lines of the stock rail and the switch rail is sufficient to allow for a practical width of switch point. The standard width of a switch point is $\frac{1}{4}$ inch.

Point of switch, theoretical. The point where the gage line of the switch rail, if produced, would intersect the gage line of the stock rail. It is also called the vertex.

Point rails. The movable rails in a split switch as distinguished from the immovable stock rails; also more properly called switch rails.

Rail. A rolled steel shape, commonly a T-section, designed to be laid end to end in two parallel lines on ties to form a track for railroad rolling stock.

Rail bearing. That portion of the tie or other support which is located beneath the base of the rail and which sustains pressure from it.

Rail bender. A tool or shop machine for bending rails to fit curves in tracks, turn-outs, turntable circles, etc.; to introduce bends in stock rails, and for a variety of allied operations.

Rail brace. A metal casting made to fit against the side of a rail or guardrail and to be spiked to the tie on the outside of a track or on the inside of a guardrail to prevent the rail from inclining backward with the thrust of the wheels.

Rail brand. An identification mark, including the manufacturer's name or initials, the month and year the rail was rolled, the weight per lineal yard and the initials of the section, the number of the heat, the portion of the ingot, and the process of manufacture.

Rail creeping. The intermittent, longitudinal sliding movement of rails in track under traffic or because of changes of temperature. It is the common practice to resist the effect of rail creeping by means of anticreepers or other similar devices,

Rail failure. A break or any other defect which necessitates removing a rail from main track.

Rail fastenings. Splice bars (also called joint bars), bolts and spikes. Splice bars joined together by bolts and bolt securing devices constitute the main members which ordinarily unite to form the rail joint, although other features are present in certain types of joints.

Rail, high. The outer or elevated rail of a curved track, extended to include the approaches to the curve where the elevation is run out upon the tangent.

Rail joint. A fastening designed to unite the ends of contiguous rails of a railroad track. The rail joint includes the general assemblage of parts necessary to make the complete rail joint, such as bolts and bolt securing devices, base plates, wood filler blocks, insulation, etc., if any of the latter are used.

Rail joint base plate. A horizontal plate designed as a bed for the base of both rails at a joint to prevent vertical movement and to add strength to the rail joint.

Rail joint expander. A device for separating contiguous rails to permit the introduction of a fiber end post/or any other object.

Rail joint, pumping. A rail joint so poorly supported that mud is churned by the passage of wheels and pumped up through the ballast.

Rail layer. A device consisting of a small crane manually or power operated and so designed that rail may be set in place with the use of a few men.

Rail loader. A machine carried on a standard flat car, consisting of demountable booms attached to a low mast and guyed to an adjustable A frame, one at each end of the car. The hoisting is

- done by compressed air drawn from the train line through storage reservoirs.
- Rail, low.** The inner rail of a curve which usually is maintained at grade, while the outer rail is elevated according to the speed and degree of curve.
- Rail, rest.** A device for supporting emergency track repair rails, consisting of two or more shelved upright posts designed to hold one or more rails.
- Rail section.** The shape of the end of a rail, cut vertically at right angles to the length.
- Relayer rail.** Worn rails suitable for use in track. Relayer rail is divided into main track relayer rails and sidetrack relayer rails.
- Rerolling rail.** A used rail selected for reheating, reworking between rolls while hot, and refinishing, to correct imperfections of wear for further main track service.
- Right of way.** The land necessary for the roadbed and its accessories.
- Rigid frog.** See Stiff frog.
- Roadbed.** The finished surface of the roadway upon which the track and ballast rest.
- Running rail.** The rail or surface on which the tread of the wheel bears, as distinguished from a wing rail, guard rail, easer rail, etc.
- Runoff (curve).** The inclined profile through which the full elevation of a curve is brought to the level of the tangent, or through which the different elevations on a compound curve are connected.
- Scrap rail.** Rails of standard section not fit for use as relayer rail.
- Screw spike.** A cylindrical, wood threaded, steel screw with a tapering square section cap designed to be turned with a special wrench into holes prebored in the tie to secure the rail or tie plate thereto.
- Self-guarded frog.** A frog provided with a guard member for guiding the flange of a passing wheel past the point of the frog by engaging the tread rim of the wheel in a horizontal plane above the top of the running surface of the frog.
- Side planing.** The cuts made on the sides of the head of the switch rail to form the taper from the full width of the head to the point.
- Spiral (when used with respect to track).** A form of easement curve in which the change of degree of curve is uniform throughout its length.
- Splice bar punching.** The spacing between centers of holes of a splice bar, punched at a height to match the standard drilling of the rails.
- Splice drilling.** The spacing of holes in the ends of rails or other track structures to receive the bolts for the fastening of splice bars.
- Split switch.** A device consisting of two tapered rails with necessary connections, designed to divert rolling stock from one track to another.
- Spot board.** A sighting board placed above and across the track at the proposed height to indicate the new surface and insure its uniformity.

- Stiff (rigid) frog.* A frog in which all the parts of the frog are rigidly constructed; generally applied only to the bolted rigid types, but not to rail bound or solid manganese steel frogs.
- Stock rail.* A running rail against which the switch point operates.
- Stock rail bend.* The bend or set which must be given the stock rail at the vertex of a switch to allow it to follow the gage line of the turn-out.
- Surface (when used with respect to track).* The condition of the track as to vertical evenness or smoothness over short distances.
- Surface (tread).* The top part of track structures on which the treads of the wheels bear.
- Switch angle.* The angle included between the gage lines of the switch rail and the stock rail.
- Switch clamp.* A clamp designed to be attached to base of the switch rail and the stock rail to prevent a disconnected or damaged switch from moving out of alignment or being thrown by error.
- Switch fixtures.* The connecting and bearing parts for the rails of a split switch.
- Switch guard.* A structure, usually of manganese steel, secured outside the running rail at the point of switch, with suitable flares to engage with the tread rim of wheels and guide them past the switch point without blow or undue wear.
- Switch plate.* A special tie plate of metal for use on switch ties, each plate being long enough to extend not only under the stock rail and its braces but also under the switch rail when in open position. Switch plates are furnished in sets to correspond with the switch length, there being two plates for each tie, except that the two at the point of switch may be replaced by a gage plate which embraces both switch rails.
- Switch rail or point rail.* The tapered rail of a split switch. To determine a right hand or left hand switch point, set the switch rail on its base, stand at the point facing the heel of the switch rail. If both the base and ball of the rail are planed off on the right hand side, it is a right hand point; if both are planed off on the left hand side, it is a left hand point.
- Switch rod, adjustable.* A switch rod supplied with an attachment by means of which its length may be altered to maintain the switch rails in their proper positions relative to the running rails. The adjustment is usually effected through staggering the holes in clips which connect the switch rod and switch rail.
- Switch stand.* An operating device by means of which a switch is thrown, locked, and its position indicated for the information of those in charge of train movements. It consists essentially of a base, a spindle, a lever and a connecting rod, and is usually furnished with a lamp and a banner signal.
- Switch target.* A visual day signal fixed upon the spindle of a switch stand or the circular flaring collar, painted a distinctive color

- and fitted around the switch lamp lens to indicate the position of the switch to those in charge of train movements.
- Switch tie.** A tie of a set used to support a turn-out or cross-over.
- Throat of frog.** The point at which the converging wings of a frog are closest together.
- Throw of switch.** The distance, measured along the center line of the rod nearest the point connecting the two switch rails, through which the switch points are measured sidewise to bring either point against the stock rail. The distance is standardized at $4\frac{3}{4}$ inches.
- Throw rod.** The rod attached to the head rod of a switch, connecting the switch to a switch stand or other operating device.
- Tie plate.** A metal plate at least 6 inches long and wide enough to provide a safe bearing area on the tie, with a shoulder to restrain outward movement of the rail and with suitable spike holes; designed to protect the face of the tie from abrasion.
- Tie plate, canted.** A tie plate tapered in thickness, usually on a cant of 1 in 20, for the purpose of inclining the rail toward the center of the track for easier maintenance of gage, more uniform wear of head and central loading of rail.
- Tie plug.** A wooden pin designed to be driven into an unused spike hole in a tie with a view of excluding moisture, preventing decay and providing solid wood for the re-driving of the spike.
- Toe end of frog.** The end of the frog in front of the point and toward the switch.
- Toe spread.** The distance between the gage lines at the toe end of the frog.
- Track brace.** An auxiliary fastening designed to function both as a rail brace and a gage rod.
- Track shim.** A plate of metal, hard wood, or fiber generally as wide as the standard tie plate, but of varying thickness; used for restoring the running surface of the track when heaved by frost or otherwise distorted.
- Turnout.** A track arrangement consisting of a switch and a frog with connecting and operating parts, and extending from the point of switch to the heel of the frog, by means of which locomotives and cars may pass from one track to another.
- Twin tie plate.** A tie plate in two parts which mate to form a combined width equal to that of the standard tie plate; for use back of the heel of the switch to the point.

APPENDIX II

REFERENCES

1. FIELD MANUALS.

- FM 4-51, Operation and Care of Railway Artillery Equipment.
- FM 5-10, Construction and Routes of Communication.
- FM 5-25, Explosives and Demolitions.
- FM 5-35, Reference Data.
- FM 55-55, Railway Operating Battalion.

2. TECHNICAL MANUALS.

- TM 1-1050, Fundamentals of Mechanical Drawing.
- TM 5-225, Rigging and Engineer Hand Tools.
- TM 5-226, Carpentry.
- TM 5-230, Topographic Drafting.
- TM 5-252, Use of Road and Airdrome Construction Equipment.
- TM 5-277, Fixed Steel Panel Bridge, Bailey Type.
- TM 5-280, Construction in the Theater of Operations (Lay-outs and Bills of Materials).
- TM 5-295, Water Supply and Water Purification.
- TM 5-371, I-Beam Railway Bridge.
- TM 5-372, Unit Construction Railway Bridge.
- TM 5-373, Through-Truss Railway Bridges.
- TM 5-374, Unit Steel Trestle, Light Standard and Standard.
- TM 5-375, V-Type Steel Trestle Equipment.
- TM 5-9164, Hammer, Pneumatic or Steam, Pile Driven, 5,000 lb. McKiernan-Terry No. 7.
- TM 9-2851, Painting.

- TM 10-590, Hand, Power, and Measuring Tools.
- TM 55-280, Operation of Railroads, Transportation Rules (when published).
- TM 55-281, Operation of Railroads, Safety Rules.
- TM 55-277, Operation of Railroads, Maintenance of Signals.

3. TECHNICAL BULLETINS.

- TB 5-277-2, Notes on Panel Bridge, Bailey Type.
- TB 5-9720-1, Technical Data for Grading, Excavating, and Earth Moving Equipment.
- TB 5-9720-7, Technical Data for Maintenance of Tools and Equipment.
- TB 5-9720-9, Technical Data for Construction Tools.
- TB 5-9720-11, Tractors and Tractor Attachments.
- TB 55-275-1, Standard Plans, Roadway, Track, and Structures.
- TB ENG 12, Stockpile Railway and Highway Bridges.
- TB ENG 42, Piles and Pile Driving.
- TB ENG 43, Use of Drums for Culvert Construction.
- TB ENG 45, Standard Steel Derricks for Erection of Railway Bridges.

4. COMMERCIAL PUBLICATIONS.

Library, Reference, Rail, Set No. 6:

Trackwork and the Section Foreman, International Textbook Co., Blue Book No. 283-C.

Maintenance of Track, International Textbook Co., Blue Book No. 284-C.

Field Engineering Text Tables by W. S. Searles and H. C. Ives.

Field Manual for Railroad Engineers by J. C. Nagle.

Lineman's Handbook by E. Kurtz.

Library, Reference, Set No. 5 (Corps of Engineers):
Building Construction Handbook, Volumes 1
and 2, by Hool and Johnson.
Civil Engineer's Handbook, by Trautwine.
American Electrician's Handbook, by Kroft.
Highway Engineer's Handbook, by Harger
and Bonney.
Mechanical Engineer's Handbook, by Marks.
Steel Construction Handbook, by AISC.
Surveying, by Davis and Foote.
Cyclopedia, Railway Engineering and Maintenance
(Simmons-Boardman).

5. FORMS.

WD AGO Form 55-246 (Water Analysis).
WD AGO Form 55-253 (Bridge Inspection Report).
WD AGO Form 55-254 (Bridge Record).
WD AGO Form 55-255 (Construction Record).
WD AGO Form 55-258 (Report of Material on
Line).
WD AGO Form 55-259 (Report of Material Changes
on Line).
WD AGO Form 55-265 (Authority for Release of
Material).
WD AGO Form 55-267 (Fuel Order).

APPENDIX III
RELATED TABLES AND DIAGRAMS

Weight	Section	Height (Inches)	Width of base (Inches)	Width of head (Inches)	Drilling			
					Height above base (Inches)	Diameter holes (Inches)	End to first hole (Inches)	First to second hole (Inches)
90	A. R. A.-A.	5 1/8	5 5/8	2 1/2	2 37/64	1 1/8	3	6
85	A. S. C. E.	5 3/16	5 3/16	2 9/16	2 17/64	1 1/8	3	6
80	A. S. C. E.	5	5	2 1/2	2 3/16	1	3	6
75	A. S. C. E.	4 13/16	4 13/16	2 15/32	---	---	---	---
70	A. S. C. E.	4 5/8	4 5/8	2 7/16	2 3/64	1	2 3/8	5
67	IS Co. 6701	4 1/2	4 1/2	2 5/16	1 25/32	1	1 1/8	5
66	IS Co. 6602	4 1/2	4 1/2	2 5/16	1 15/16	1	2 15/16	6
65	A. S. C. E.	4 1/16	4 1/16	2 13/32	1 31/32	1	2 3/8	5
60	A. S. C. E.	4 1/4	4 1/4	2 3/8	1 115/128	1	4 1/2	9
56	IS Co. 5601	4	3 7/8	2 5/32	1 21/32	1	2 3/8	5
52	E. T. Co. 145	3 63/64	3 3/4	2 5/64	1 37/64	1	3 1/2	5

Figure 17. Dimensions of standard rail sections.

Rails will be curved in accordance with the following table, which gives the middle ordinate of a curved rail. Stretch a line from end of rail on inside of curvature. The distance from the edge of rail to the line at the exact center of rail is the middle ordinate. Ordinates at the quarters are three-fourths of the middle ordinate.

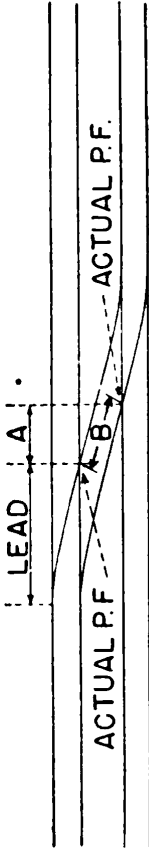
Degree of curve	Length of rails in feet		
	30	33	39
	(Inches)	(Inches)	(Inches)
6°	1 $\frac{3}{8}$	1 $\frac{3}{4}$	2 $\frac{3}{8}$
7°	1 $\frac{5}{8}$	2	2 $\frac{3}{4}$
8°	1 $\frac{7}{8}$	2 $\frac{1}{4}$	3 $\frac{1}{8}$
9°	2 $\frac{1}{8}$	2 $\frac{1}{2}$	3 $\frac{5}{8}$
10°	2 $\frac{3}{8}$	2 $\frac{7}{8}$	4
11°	2 $\frac{5}{8}$	3 $\frac{1}{8}$	4 $\frac{3}{8}$
12°	2 $\frac{7}{8}$	3 $\frac{3}{8}$	4 $\frac{3}{4}$
13°	3	3 $\frac{3}{4}$	5 $\frac{1}{8}$
14°	3 $\frac{1}{4}$	4	5 $\frac{1}{2}$
15°	3 $\frac{1}{2}$	4 $\frac{1}{4}$	6

Figure 18. Table of middle ordinates for curving rails.

Gage	Switch point	Lead
2-6	11-0	32' 0''
3-0	11-0	38' 0''
3-1 $\frac{3}{8}$	11-0	38' 0''
3-3	11-0	42' 0''
3-3 $\frac{3}{8}$	11-0	42' 0''
3-5 $\frac{1}{2}$	11-0	42' 0''
3-6	11-0	42' 0''
4-8 $\frac{1}{2}$	16-6	68' 0''
5-0	16-6	68' 0''
5-3	16-6	75' 0''
5-6	16-6	75' 0''

Heel spread at switch=6 $\frac{1}{4}$ ''.

Figure 19. Table of recommended leads for various gages using standard No. 8 frog and 11-foot 0-inch or 16-foot 6-inch switch points.



Frog No.	Leads	Frog angles	Distance between track centers					
			12 feet		13 feet		14 feet	
			A	B	A	B	A	B
5	42'-6"	11° 25'	11' 10 ³ / ₄ "	13' 1 ¹ / ₄ "	16' 10 ¹ / ₄ "	18' 1 ³ / ₄ "	21' 9 ³ / ₄ "	23' 2 ¹ / ₂ "
6	47'-6"	9° 32'	14' 6"	15' 6"	20' 5 ¹ / ₂ "	21' 6 ¹ / ₂ "	26' 5"	27' 7"
7	62'-1"	8° 10'	17' 1"	17' 11"	24' 0 ¹ / ₂ "	24' 11 ³ / ₄ "	31' 0"	32' 0"
8	68'-0"	7° 09'	19' 7 ¹ / ₂ "	20' 4 ¹ / ₂ "	27' 7"	28' 5"	35' 6 ³ / ₄ "	36' 5 ¹ / ₄ "
9	72'-3"	6° 22'	22' 2"	22' 10"	31' 1 ³ / ₄ "	31' 10 ¹ / ₂ "	40' 1 ¹ / ₂ "	40' 10 ³ / ₄ "
10	78'-9"	5° 43'	24' 8 ¹ / ₄ "	25' 3 ³ / ₄ "	34' 8"	35' 4"	44' 8"	45' 4 ¹ / ₄ "
12	96'-8"	4° 46'	29' 9"	30' 3"	41' 8 ³ / ₄ "	42' 3 ¹ / ₄ "	53' 8 ¹ / ₂ "	54' 3 ¹ / ₂ "
14	107'-1"	4° 05'	34' 9 ¹ / ₂ "	35' 2 ¹ / ₂ "	48' 9 ¹ / ₄ "	49' 2 ³ / ₄ "	62' 9"	63' 3"
15	126'-4"	3° 49'	37' 3 ¹ / ₄ "	37' 8 ¹ / ₂ "	52' 3 ¹ / ₂ "	52' 8 ¹ / ₂ "	67' 3 ¹ / ₄ "	67' 8 ³ / ₄ "
16	131'-4"	3° 35'	39' 9 ¹ / ₂ "	40' 2 ¹ / ₄ "	55' 9 ³ / ₄ "	56' 2 ¹ / ₂ "	71' 9 ¹ / ₂ "	72' 2 ³ / ₄ "
18	140'-11"	3° 11'	44' 10"	45' 2"	62' 10"	63' 2 ¹ / ₄ "	80' 9 ³ / ₄ "	81' 2 ¹ / ₂ "
20	151'-11"	2° 52'	49' 10"	50' 1 ³ / ₄ "	69' 10"	70' 2"	89' 10"	90' 2"

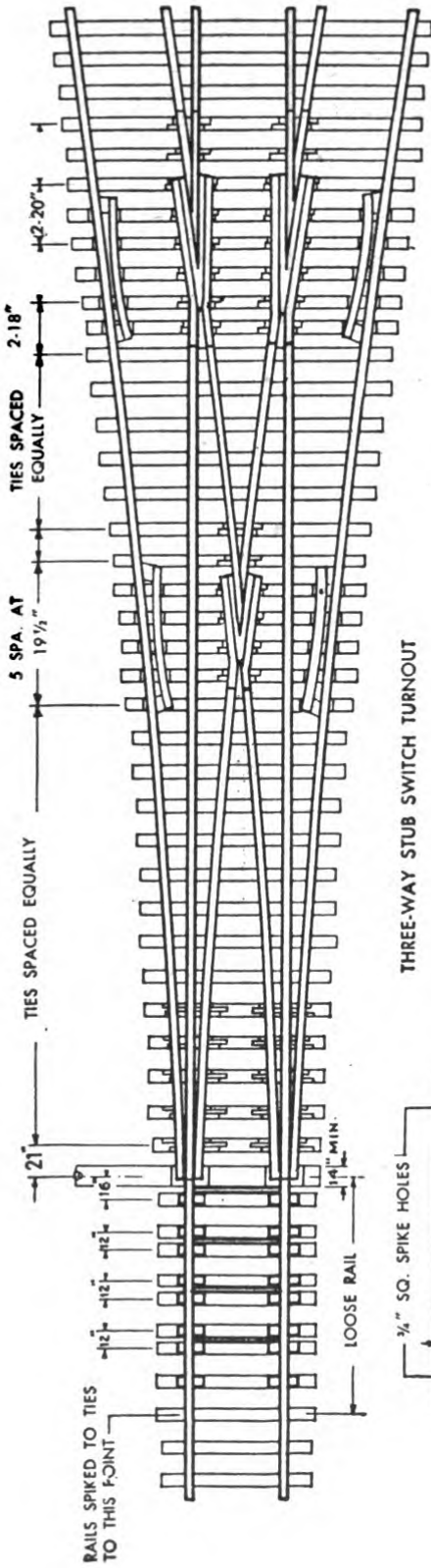
Frog No.	Leads	Frog angles	Distance between track centers					
			15 feet		18 feet		20 feet	
			A	B	A	B	A	B
5	42'-6"	11° 25'	26' 9"	28' 3"	41' 7 ¹ / ₄ "	43' 5"	51' 6"	53' 6"
6	47'-6"	9° 32'	32' 4 ¹ / ₂ "	33' 7 ¹ / ₂ "	50' 3"	51' 9"	62' 2"	63' 10"
7	62'-1"	8° 10'	37' 11 ³ / ₄ "	39' 0 ¹ / ₂ "	58' 10 ¹ / ₄ "	60' 2"	72' 9 ¹ / ₂ "	74' 2 ³ / ₄ "
8	68'-0"	7° 09'	43' 6 ¹ / ₂ "	44' 5 ³ / ₄ "	67' 5 ¹ / ₄ "	68' 6 ³ / ₄ "	83' 4 ¹ / ₂ "	84' 7 ¹ / ₂ "
9	72'-3"	6° 22'	49' 1"	49' 11"	76' 0"	77' 0"	93' 11 ¹ / ₂ "	95' 0 ¹ / ₂ "
10	78'-9"	5° 43'	54' 7 ¹ / ₂ "	55' 4 ¹ / ₂ "	84' 6 ¹ / ₂ "	85' 5 ¹ / ₂ "	104' 6 ¹ / ₄ "	105' 6"
12	96'-8"	4° 46'	65' 8 ¹ / ₄ "	66' 3 ³ / ₄ "	101' 7 ¹ / ₂ "	102' 4 ¹ / ₂ "	125' 7"	126' 5"
14	107'-1"	4° 05'	76' 9"	77' 3 ¹ / ₄ "	118' 8 ¹ / ₄ "	119' 4"	146' 8"	147' 4 ¹ / ₂ "
15	126'-4"	3° 49'	82' 3"	82' 9"	127' 2 ¹ / ₂ "	127' 9 ³ / ₄ "	157' 2"	157' 10"
16	131'-4"	3° 35'	87' 9 ¹ / ₄ "	88' 3"	135' 8 ³ / ₄ "	136' 3 ¹ / ₂ "	167' 8 ¹ / ₄ "	168' 3 ³ / ₄ "
18	140'-11"	3° 11'	98' 9 ¹ / ₂ "	99' 2 ¹ / ₂ "	152' 9"	153' 3"	188' 8 ¹ / ₂ "	189' 3 ¹ / ₂ "
20	151'-11"	2° 52'	109' 9 ³ / ₄ "	110' 2 ¹ / ₄ "	169' 9 ¹ / ₂ "	170' 2 ³ / ₄ "	209' 9"	210' 3"

Figure 20. Table of leads and coordinates for standard gage crossovers.

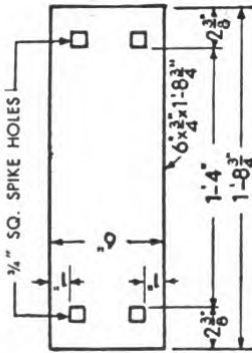
Frog No.	Frog angle	Length of frog		Length of switch points	Degree of turn-out curve	Length of lead	Total length of connecting rail
		Point to toe	Point to heel				
5	11° 25'	3' 6½"	5' 5½"	11' 0"	32° 40'	42' 6"	56' 4"
6	9° 32'	3' 9"	6' 3"	11' 0"	22° 18'	47' 6"	65' 9"
7	8° 10'	4' 8½"	7' 3½"	16' 6"	15° 43'	62' 1"	82' 0"
8	7° 09'	5' 1"	7' 11"	11' 0"	11° 05'	60' 11"	90' 0"
9	6° 22'	6' 4½"	9' 7½"	16' 6"	11° 47'	68' 0"	93' 0"
10	5° 43'	6' 5"	10' 1"	16' 6"	9° 20'	72' 3"	99' 0"
11	5° 12'	7' 0"	11' 8½"	16' 6"	7° 21'	78' 9"	111' 10"
12	4° 46'	7' 9½"	12' 6½"	22' 0"	6° 11'	91' 10"	125' 10"
14	4° 05'	8' 7½"	14' 11½"	22' 0"	5° 11'	96' 8"	133' 10"
15	3° 49'	9' 5"	14' 11½"	22' 0"	3° 37'	107' 1"	153' 0"
16	3° 35'	9' 5"	16' 7"	30' 0"	3° 20'	126' 4"	174' 0"
18	3° 11'	11' 0½"	18' 2½"	30' 0"	2° 51'	131' 4"	183' 11"
20	2° 52'	11' 0½"	19' 10"	30' 0"	2° 13'	140' 11"	199' 11"
				30' 0"	1° 44'	151' 11"	221' 11"

Frog No.	Frog angle	Gage line offsets					
		A	B	C	D	E	F
5	11° 25'	18' 0"	25' 0"	32' 0"	12"	20½"	2' 9"
6	9° 32'	19' 2¼"	27' 4½"	35' 6¾"	12½"	21½"	2' 10"
7	8° 10'	26' 2¼"	35' 10½"	45' 6¾"	11½"	19½"	2' 7"
8	7° 09'	27' 7¼"	38' 8½"	49' 9¾"	12"	20½"	2' 8½"
9	6° 22'	28' 10¼"	41' 2½"	53' 6¾"	12"	21½"	2' 9½"
10	5° 43'	29' 11¾"	43' 5½"	56' 11¼"	12½"	21"	2' 8½"
11	5° 12'	37' 8½"	53' 5"	69' 1½"	12½"	21½"	2' 10"
12	4° 46'	38' 8½"	55' 5"	72' 1½"	12½"	21½"	2' 10"
14	4° 05'	41' 1¼"	60' 2½"	79' 3¾"	13"	22½"	2' 10½"
15	3° 49'	51' 9"	73' 6"	95' 3"	12"	21"	2' 10"
16	3° 35'	53' 0"	76' 0"	99' 0"	12½"	22"	2' 10"
18	3° 11'	55' 0"	80' 0"	105' 0"	13"	22"	2' 10½"
20	2° 52'	57' 9"	85' 6"	113' 3"	13"	22½"	2' 11"

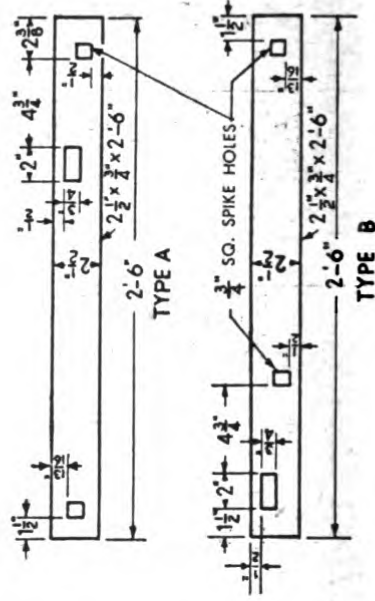
Figure 21. Standard gage turn-out data.



THREE-WAY STUB SWITCH TURNOUT



SWITCH PLATE



THREE RAIL TIE PLATES

Figure 22. Standard gage three-way stub turn-outs (details 5, 8, 8-6, 8, 8-8, 8, 8).

#5 CROTCH FROG — #8 TURNOUT FROGS

GAUGE	BARIUS	CROTCH LEAD	TURNOUT LEAD	TANGENT AT CROTCH	TANGENT AT TURNOUT	SWITCH LENGTH	CLOSURE TO CROTCH	CLOSURE TO TURNOUT	STRAIGHT CLOSURE
3'-0"	122.25	11.48	13.53	5.65	—	7.36	7.99	3.08	19.93
3'-1 1/2"	142.57	12.27	14.04	5.21	—	7.95	8.79	3.59	21.23
3'-3"	166.58	13.29	14.64	4.69	—	8.60	9.81	4.19	22.85
3'-3 3/4"	172.12	13.53	14.78	4.57	—	8.74	10.05	4.33	23.23
3'-5 1/4"	201.69	14.88	15.52	3.93	—	9.46	11.40	5.08	25.32
3'-6"	210.92	15.31	15.75	3.74	—	9.68	11.84	5.31	25.98
4'-8 1/2"	407.54	26.12	21.07	—	0.40	13.46	22.64	10.66	42.11
5'-0"	436.92	28.41	22.30	—	0.91	13.94	24.95	11.91	45.63
5'-3"	462.10	30.38	23.37	—	1.34	14.34	26.93	12.97	48.67
5'-6"	487.29	32.38	24.42	—	1.77	14.72	28.93	14.04	51.72

#6 CROTCH FROG — #8 TURNOUT FROGS

GAUGE	BARIUS	CROTCH LEAD	TURNOUT LEAD	TANGENT AT CROTCH	TANGENT AT TURNOUT	SWITCH LENGTH	CLOSURE TO CROTCH	CLOSURE TO TURNOUT	STRAIGHT CLOSURE
3'-3"	114.08	14.99	16.00	11.32	—	7.11	11.30	4.76	25.91
3'-3 3/4"	117.69	15.18	16.15	11.36	—	7.22	11.49	4.91	26.25
3'-5 1/4"	136.94	16.22	16.95	11.56	—	7.79	12.53	5.71	28.09
3'-6"	142.96	16.37	17.20	11.63	—	7.96	12.87	5.96	28.69
4'-8 1/2"	282.37	25.30	22.99	13.10	—	11.21	21.63	11.78	43.21
5'-0"	316.25	27.58	24.39	13.45	—	11.86	23.92	13.18	46.89
5'-3"	345.13	29.59	25.58	13.75	—	12.39	25.92	14.39	50.09
5'-6"	374.01	31.60	26.78	14.06	—	12.90	27.94	15.60	53.30

#8 CROTCH FROG — #8 TURNOUT FROGS

GAUGE	BARIUS	CROTCH LEAD	TURNOUT LEAD	TANGENT AT CROTCH	TANGENT AT TURNOUT	SWITCH LENGTH	CLOSURE TO CROTCH	CLOSURE TO TURNOUT	STRAIGHT CLOSURE
3'-5 1/4"	105.89	21.58	19.53	19.58	—	9.50	16.54	6.61	36.03
3'-6"	110.36	22.00	19.80	19.86	—	9.50	16.96	6.89	36.72
4'-8 1/2"	213.90	31.66	26.24	26.31	—	9.75	26.64	13.35	52.82
5'-0"	238.89	34.05	27.79	27.87	—	10.30	29.03	14.91	56.76
5'-3"	260.31	36.11	29.12	29.20	—	10.75	31.09	16.25	60.15
5'-6"	281.74	38.20	30.45	30.54	—	11.19	33.19	17.59	63.57

Figure 23a. Dimensions of cross frogs and turn-out frogs.

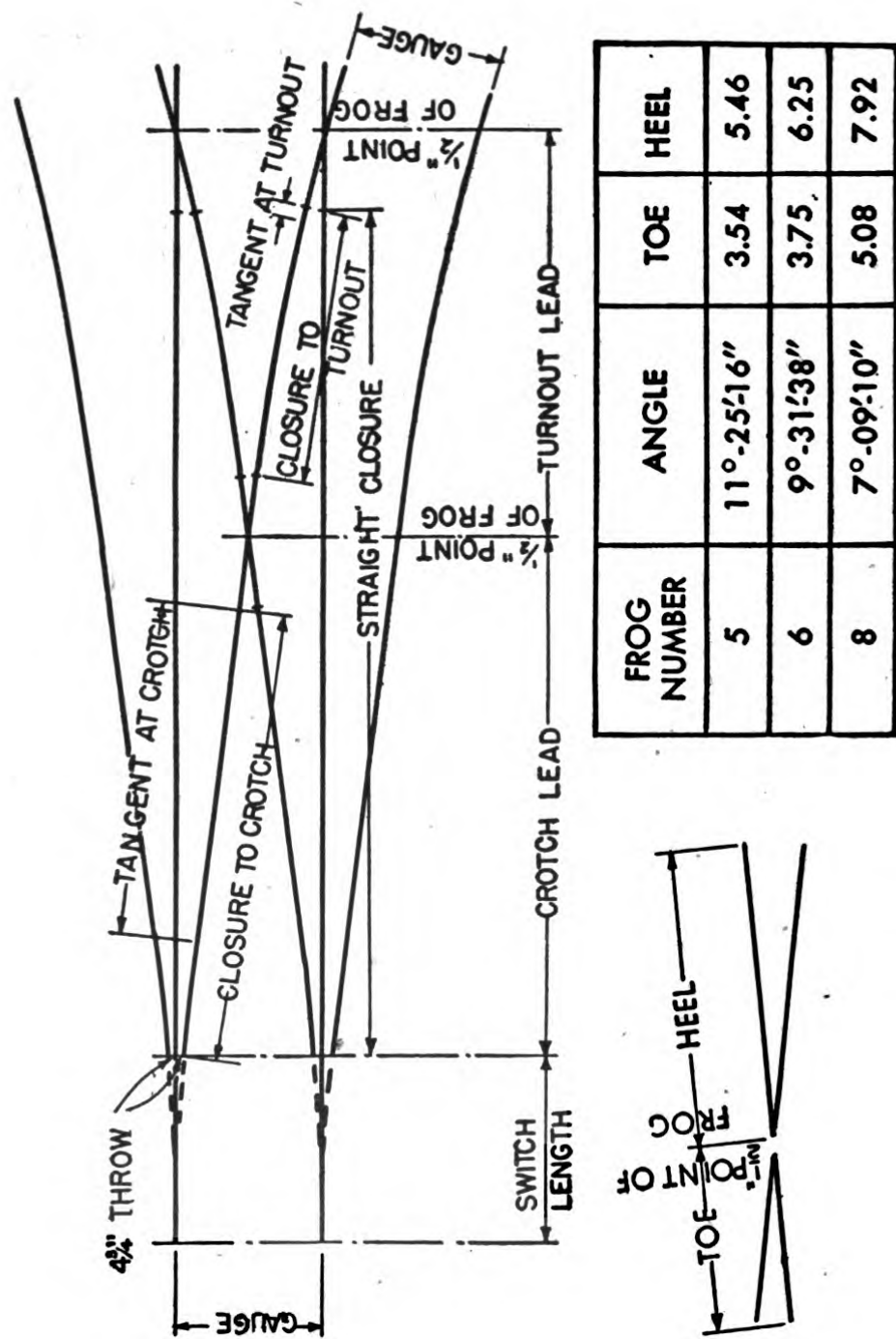


Figure 23b. Dimensions of standard gage three-way stub turn-outs (dimensions 5, 8, 8-6, 8, 8-8, 8, 8, 8).

LENGTH OF TRACK TIE TO BE USED VARIOUS GAUGE			
GAGE	2'-6"	3'-0" 3'-1"	3'-3" TO 3'-6" 4'-8" 5'-0" 5'-6"
LENGTH	5'-6"	6'-6"	8'-0" 9'-0"

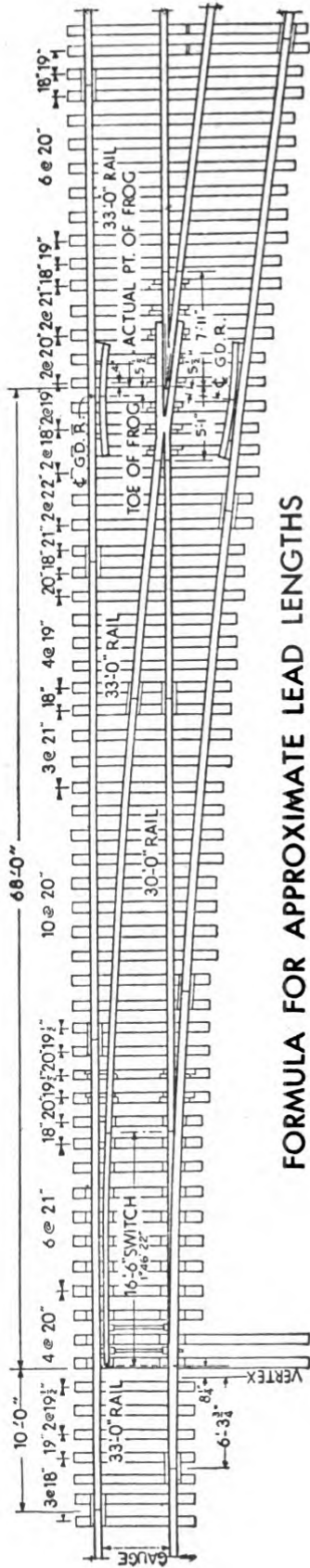
BILL OF SWITCH TIES — VARIOUS GAUGE						
LENGTH	GAUGE					
	2'-6"	3'-0" 3'-1 1/2"	3'-3" 3'-3 3/4"	4'-8 1/2" 5'-0"	5'-3" 5'-6"	
5'-0"						
5'-6"						
6'-0"	7					
6'-6"	4					
7'-0"	2	7	7			
7'-6"	3	3	5			
8'-0"	2(F-2)	3	2			
8'-6"	3	2	3	12		
9'-0"	2	3	2	7		
9'-6"	3	2	2	4	11	
10'-0"	2	2(F-1)	3(F-3)	3	9	
10'-6"	3	3	2	2	4	
11'-0"		2	3	3	3	
11'-6"	2*	2	2	2	3	
12'-0"		2	2	2	2	
12'-6"		4*	5*	3	2	
13'-0"					2(F-2)	3
13'-6"					2	2
14'-0"					5*	3
14'-6"					2	2(F-2)
15'-0"					3	5*
15'-6"					2	2
16'-0"						
16'-6"						
17'-0"						
17'-6"						
18'-0"						
18'-6"						
TOTAL PCS	33	35	38	54	60	
LIN. FT.	267	329	358 1/2	599 1/2	747	

NOTE: * INDICATES HEADBLOCK
(F-1) INDICATES 1ST TIE OF THAT LENGTH TO BE LOCATED UNDER FROG POINT

LEADS TO BE USED FOR VARIOUS GAUGE				
A.R.E.A. STD. NO. 8 FROG. ANGLE 7°09'				
HEEL SPREAD AT SWITCH 6 1/4"				
SWITCH ANGLE 11' = 2°39' 16'-6" = 1°46'				
FEET	GAUGE		SW. POINT	LEAD
	INCHES	METER		
2'-6"		0.76	11'-0"	32'-0"
3'-0"		0.91	11'-0"	38'-0"
3'-1 1/2"		0.95	11'-0"	38'-0"
3'-3"		0.99	11'-0"	42'-0"
3'-3 3/4"		1.00	11'-0"	42'-0"
3'-5 1/4"		1.05	11'-0"	42'-0"
3'-6"		1.07	11'-0"	42'-0"
4'-8 1/2"		1.44	16'-6"	68'-0"
5'-0"		1.52	16'-6"	68'-0"
5'-3"		1.60	16'-6"	75'-0"
5'-6"		1.68	16'-6"	75'-0"

RADIUS—STRAIGHT CLOSURE & CURVED— CLOSURE FOR VARIOUS GAUGE			
GAUGE	RADIUS OF OUTER RAIL	STRAIGHT CLOSURE	CURVED CLOSURE
2'-6"	198.37	15.917	16.020
3'-0"	280.02	21.917	22.041
3'-1 1/2"	240.03	21.917	22.052
3'-3"	302.96	25.917	26.050
3'-3 3/4"	313.10	25.917	26.053
3'-5 1/4"	297.48	25.917	26.068
3'-6"	280.66	25.917	26.072
4'-8 1/2"	489.69	46.417	46.611
5'-0"	437.41	46.417	46.638
5'-3"	563.43	53.417	53.635
5'-6"	522.65	53.417	53.658

Figure 24a. Dimensions for switch ties, track ties, leads, and radii for various gauges.



FORMULA FOR APPROXIMATE LEAD LENGTHS

16'-6" SWITCH $L = 7 + 12.8 G$.

11'-0" SWITCH $L = 7 + 11.6 G$

WHEN $L =$ APPROXIMATE PRACTICAL LEAD IN FEET

$G =$ GAUGE IN FEET

Figure 24b. No. 8 turn-out.

BILL OF MATERIAL		A.R.E.A. SPEC. 112-G
16'6" NON-INSULATED STRAIGHT SPLIT SWITCH WITH RIGID RAIL BRACES		DETAIL NO
DESCRIPTION		
2	DOUBLE REINFORCED SWITCH POINTS COMPLETE WITH DETAILS FOR SIDE JAW CLIPS	3/4"
2	NON-INSULATED SWITCH RODS 1—NO. 1	2 1/2" x 1"
	1—NO. 2	2 1/2" x 1"
16	RAIL BRACES 1/2" THICK	6" WIDE
16	SOLID BASE SLIDE PLATES 14—NO. 1 1/4" RISER	6" WIDE
	2—NO. 2 1/8" RISER	6" WIDE
2	SHOULDER SLIDE PLATES NO. 3—NO RISER	6" WIDE
4	SHOULDER HEEL PLATES 1 PR. NO. 4 R.H. AND L.H.	7" WIDE
	1 PR. NO. 5 R.H. AND L.H.	7" WIDE
28	TWIN TIE PLATES 14 TYPE NO. 1	3 1/2" x 3/4"
	14 TYPE NO. 2	3 1/2" x 3/4"
2	HEEL BLOCKS, COMPLETE WITH BOLTS, JOINT BARS AND THIMBLES	
2	STOPS TO BE ASSEMBLED WITH SWITCH POINTS	1125 (ALT.)
		1024

Figure 25a. Bill of material—16-foot 6-inch noninsulated straight split switch with rigid rail braces.

BILL OF MATERIAL		
11'0" NON-INSULATED STRAIGHT SPLIT SWITCH WITH RIGID RAIL BRACES	A.R.E.A. SPEC. 114-G	DETAIL NO.
DESCRIPTION		
2 DOUBLE REINFORCED SWITCH POINTS, COMPLETE, WITH DETAILS FOR SIDE JAW CLIPS	3/4"	2112
2 NON-INSULATED SWITCH RODS 1 NO. 1	2 1/2" x 1"	2010
1 NO. 2	2 1/2" x 1"	2011
12 RAIL BRACES 1/2" THICK	6" WIDE	2022
12 SOLID BASE SLIDE PLATES 10 NO. 1 1/4" RISER	6" WIDE	1120R
2 NO. 2 1/8" RISER	6" WIDE	1121R
2 STOPS TO BE ASSEMBLED WITH SWITCH POINT		1024
4 SHOULDER HEEL PLATES 1 PR. NO. 3 R.H. & L.H.	7" WIDE	2140
1 PR. NO. 4 R.H. & L.H.	7" WIDE	2149
16 TWIN TIE PLATES		
8 TYPE NO. 1	3 1/2" WIDE	
8 TYPE NO. 2	3 1/2" WIDE	
2 HEEL BLOCKS, COMPLETE, WITH BOLTS, JOINT BARS, AND THIMBLES		1125 (ALT.)

Figure 26. Straight split switch (11 feet) with graduated risers.

Frog No.	Lengths and quantities of ties												Quantity of ties	Board measure			
	8'0"	8'6"	9'0"	9'6"	10'0"	10'6"	11'0"	11'6"	12'0"	12'6"	13'0"	13'6"			14'0"	14'6"	15'0"
5	0	0	6	4	3	1	2	2	2	2	1	2	1	1	2	33	2, 027
6	0	0	6	4	4	2	2	2	2	2	2	2	2	2	2	38	2, 352
7	0	0	9	7	4	3	3	3	2	2	2	2	2	2	2	48	2, 880
8	6	9	0	4	4	4	4	4	3	2	2	2	2	3	4	55	2, 875
9	0	0	9	8	5	4	3	3	3	4	4	4	3	3	2	57	3, 457
10	0	0	9	8	5	4	4	3	3	4	3	3	3	3	3	62	3, 809
11	0	0	13	12	6	5	4	3	3	4	3	4	3	3	3	72	4, 302
12	0	0	13	12	6	5	4	3	3	4	3	4	3	3	3	76	4, 583
14	0	0	13	12	6	5	4	3	3	4	3	4	3	3	4	85	5, 182
15	0	0	17	14	8	5	4	3	3	4	3	4	3	3	4	98	5, 891
16	0	0	17	15	9	7	6	5	5	5	4	4	4	4	5	103	6, 221
18	0	0	17	16	11	8	7	6	6	6	5	5	5	5	6	110	6, 654
20	0	0	17	16	11	8	8	6	6	7	6	7	7	6	6	121	7, 400

Figure 30. Bill of timber for standard gage turnouts.

Multiply	by		Multiply	by		to obtain
	to obtain	to obtain		to obtain	to obtain	
Inches	2.54001	Centimeters.	Pounds (avoirdupois)	.453592	Kilograms.	
Centimeters	.3937	Inches.	Kilograms	2.20462	Pounds.	
Feet	.304801	Meters.	Kilometers	.62137	Miles (statute).	
Meters	3.28083	Feet.	Miles (statute)	1.60935	Kilometers.	
Yard	.914402	Meters.	Acres	.404687	Hectares.	
Meters	1.09361	Yards.	Hectares	2.47104	Acres.	

Figure 31. Conversion table.

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