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# AN INTRODUCTION TO RAILROAD OPERATIONS

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JUNE 1972

FINAL REPORT

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16. Abstract

This report provides an overview of railroad operations as a guide for consultants and contractors unfamiliar with railroading. It includes definitions of railroad terms, a description of a typical railroad management organization, discussion of regulatory bodies and labor relations, and a detailed description of train operations, including signals, brake systems, locomotives, yard and freight operations, and the duties of the engineman.

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## PREFACE

In the summer of 1971, Mr. Wilfred H. Holland, Consultant, prepared a short report for TSC intended to provide background indoctrination on railroad operations for personnel working on PPA-RR-209, Human Factors in Railroad Operations. The project, sponsored by the Office of Policy and Planning, Federal Railroad Administration, was under the technical monitorship of Dr. D. B. Devoe, TSC, Technology Directorate, Human Factors Branch.

This report proved to be a valuable reference document for research personnel unfamiliar with railroads. Therefore, it has been revised and augmented for publication as a contractor report in the hope that it may be more readily available to other technical groups (consultants and contractors to DOT and FRA) who could benefit from a concise, lucid introduction to the complexities of railroading.

Figure 3, 4, 5, 6, 7 and 8 in the report are reproduced from: "Modern Freight Train Handling," 1967, with the kind permission of the publisher:

The Air Brake Association
Railway Exchange Building
Chicago, Illinois

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# 1.0 DEFINITIONS OF RAILROAD TERMS

RAILROAD

A track, (or a system of tracks), formed by two parallel rails along which cars are propelled by power units for the movement of goods and/or people.

TRAIN

An engine or more than one engine coupled, with or without cars, displaying markers.

ENGINE

A unit propelled by any formofenergy, or a combination of such units operated from a single control, used in train or yard service.

ENGINEMAN

The person operating the locomotive of a train, often called Engineer.

LOCOMOTIVE

A powered unit which singly, (or in multiple), constitutes an engine.

CAR

A wheeled vehicle running on tracks and used for the conveyance of passengers, baggage, freight, or company material.

PASSENGER TRAIN CAR

A car of suitable construction, equipped to operate in passenger trains. This group includes the following general classifications:

1. Passenger carrying cars
2. Baggage cars
3. Mail cars

4. Combination passenger and baggage or mail

5. Freight carrying cars especially equipped for handling in passenger trains.

RAIL MOTOR CAR, PASSENGER

A passenger carrying car propelled by internal combustion engines, either directly or indirectly. May be used singly or equipped to be used in multiple.

FREIGHT CAR

A car of suitable construction equipped to operate in freight trains. This group includes the following general classifications:

1. Box - A weather tight car far handling general commodities.

2. Refrigerator - A box type car equipped to maintain temperature within specified limits.

3. Stock cars - for the transportation of livestock.

4. Gondola - open top car with fixed sides, fixed or drop ends, and with solid or drop bottoms.

5. Hopper - An open top car with fixed sides and sloping ends provided with hinged doors at the bottom for rapid discharge of lading such as coal or gravel.

6. Tank Cars

7. Flat cars for:

   a. General purpose
   b. Handling highway truck trailers

8. Specialized cars for movement of particular commodities.

TRACK, COMPONENTS AND ACCESSORIES

1. Turnout - Provides a means for routing a train from one track to another connecting track, the principal components of which are:

   a. Switch Points - Hinged rails with the ends ground to lie flat against the inside of the rails of the

principal track so that when they are moved horizontally the wheels of a train will be guided along either the principal track or the "turnout track". Switch points are connected by rods to a switch stand with a lever for throwing the switch manually and with a "target" and light to indicate to an approaching train the position of the switch. The switch may also be operated electrically by remote control or, if manually operated, may have an electric lock under the control of a remote operator.

2. Derail - A protective device that can be placed on a rail to derail equipment moving from a secondary track or siding onto a main or running track. The derail is placed far enough in advance so that derailed equipment will not foul the main or running track; it may be fixed and operated by a lever or it may be portable.

3. Bunter - A fixed device designed to stop railroad equipment from running off the ends of dead-end tracks. It may be of steel with a cushioning device, or concrete. (Frequently used in Passenger Stations.)

4. Wheel Stops - Serve the same purpose as a bunter but are less substantial and may be portable or fastened to the rails. (Frequently used on yard or industrial tracks.)

TRACK, CLASSES

While the Company book of Operating Rules generally defines Main, Single, Multiple, Running, Secondary Tracks and Sidings, additional commonly used track designations are:

1. Side Track - Serving one or more industries located on that track and having exclusive use of it or a segment thereof.

2. Public Delivery Track or Team Track - A track or group of tracks, located in a yard and available for customers to load or unload freight cars.

3. Classification Track - One of a group of tracks in a yard used for separating cars into groups according to destination for later forwarding in local freight trains or for proper make up of thru freights or for handling in a transfer train, or by an industrial switcher.

4. Receiving Track - A track on which an arriving freight train "drops" its cars at a terminal for later classification; this may be at a final terminal or at an intermediate point.

5. Departure Track - A track used to make up trains for departure with the cars grouped in station order. In major yards the track will have yard air at the proper pressure available to charge the airbrake system to permit preliminary testing and proper car inspection prior to coupling on the road engine.

6. Storage Track - Used to hold cars temporarily.

7. Lead Track - A track from which a group of other tracks turns out, or which leads to a designated territory.

8. Repair or Shop Track - A track designated to perform repair work on cars or to hold cars for such work, (commonly referred to as "Rip" track).

9. Engine House Track - A track in designated enginehouse territory on which to hold locomotives for repair or servicing.

YARD

A system of tracks within defined limits provided for the making up of trains, storing of cars and other purposes, over which movements not authorized by timetable, or by train order, may be made, subject to prescribed signals and rules, or special instructions.

A yard may contain all or some of the tracks defined herein as items (1) thru (9) under the heading, "Track Classes", and may additionally have main tracks running through it or adjacent to it.

A yard may have one or more yard crews assigned for switching purposes and may be under the jurisdiction of a General Yardmaster assisted by one or more Trick Yardmasters; at the other extreme, there may be no yard switchers assigned to the yard and the work is then performed by the Local Freight, or Road Switcher Crews, at the direction of the Trainmaster or Freight Agent.

INITIAL TERMINAL

The point where a train originates.

FINAL TERMINAL

The final destination of a train.

INTERMEDIATE TERMINAL OR POINT

The location where a thru train drops or picks up cars, (generally in groups), or where engines or crews may be changed.

THRU FREIGHT TRAIN

One that runs from Initial to Final Terminal without stopping, or stops only to drop or pick up blocks of cars at intermediate points, or stops only to change engines and/or crews.

NOTE

Freighttrains' schedules are ***not*** normally shown in the Timetable, but, for the convenience of all concerned, the planned departure and arrival times, as well as the time at intermediate terminals, are generally shown in a separate Freight Train Symbol Book, or a similarly entitled book. The symbol book carries no timetable authority.

LOCAL FREIGHT TRAIN OR ROAD SWITCHER

Does work within assigned geographical limits. The work normally consists of placing and picking up cars at industrial sidings, public delivery tracks and switching tracks at railroad-owned and industry-owned yards where there is no assigned yard switcher.

A local freight may be set up as a Turnaround Job, returning to its Initial Terminal at the end of its tour of duty, or scheduled to run from an Initial Terminal to a Final Terminal one day and return the next day.

YARD SWITCHER

An engine and crew assigned to work in a yard, as defined in the book of operating rules and as designated in the timetable and by yard limit boards.

The work will consist of sorting out cars by destination on classification tracks, then reassembling the cars, blocked in station order, on a departure track, for the road engines of departing local and thru freights to couple onto. A yard switcher will also place and pick up cars at industrial sidings and public delivery tracks located within yard limits. In small and medium sized yards the classification work will be done by "flat switching", i.e., the engine shoves cars onto the designated classification track.

In major yards handling a large volume of cars daily, the classification work may be done by use of a "gravity hump". Here the cars are shoved by an engine along the hump lead. At the crest of the hump the cars are uncoupled manually, either singly or in groups, allowed to roll down the descending grade of the hump and then routed thru a series of turnouts to the proper classification track. The cars are then gathered by a yard crew for assembly on a departure track, properly blocked.

TRANSFER TRAIN

A train assigned to handle cars between yards.

JOINT OPERATION

Operation by the employees of more than one railroad company within the limits of a jointly used facility, (such as a track, yard, terminal or station), by agreement between the companies. The agreement will clearly specify under what operating and mechanical rules and under whose authority and

responsibility operations will be conducted; all employees working within the territory must qualify and conform in all respects.

INTERCHANGE POINT

A location where cars and equipment are exchanged between railroads of different ownership. It is the responsibility of the delivering railroad to place cars on a designated interchange track, or tracks, of the receiving railroad.

Both the delivering and receiving railroad will maintain records of the time of interchange and of the identifying marks of the equipment for purposes of per diem settlement and car tracing.

The receiving railroad will promptly inspect equipment offered in interchange and may refuse to accept any equipment when the condition of the equipment or the lading fails to meet the standards of the A.A.R. Mechanical Division Interchange Rules.

PER DIEM

A rate of compensation established for the use of freight cars by the using railroad and paid to the railroad owning the car.

DEMURRAGE

A rate established for the payment by an industry or an individual, to the railroad placing the car, for detention of a car in excess of a predetermined number of days.

A.A.R.

Abbreviation for the Association of American Railroads.

The Association is a voluntary, non-profit, unincorporated organization, composed of most of the Railroads of North America. The A.A.R. maintains a sizeable full-time staff in Washington, D.C. plus a research section. In addition to the permanent employees, the A.A.R. has many standing committees composed of working railroad men who are specialists in

the area of consideration of the particular committee to which they are elected.

The A.A.R. has developed a degree of standardization of equipments to permit interchange among its members. It has established and published rules for the settlement of car hire and demurrage which have been adopted by the Interstate Commerce Commission, as well as the Mechanical Division Interchange rules.

The A.A.R has worked toward the modernization and standardization of all practices employed by the railroad industry. It also works closely with the National Industrial Traffic League and with private car owners.

## 2.0 RAILROAD CLASSIFICATIONS

Since railroads exist in varying degrees of complexity ranging from what may be essentially a short one-track line to a system comprised of thousands of miles of tracks with numerous terminals, yards, and attendant facilities, they are generally classified as follows:

Class I Railroads - (for purposes of the annual report to the Interstate Commerce Commission); those having annual operating revenues of $5,000,000.00 or more.

Class II Railroads - (for purposes of the annual report to the I.C.C.), those having annual operating revenues below $5,000,000.00.

They may be further classified as:

Switching Railroads - those performing switching service only, whether for joint account or revenue.

Terminal Railroads - those furnishing trackage or terminal facilities only, for which a charge is made, such as union freight or passenger facilities, yards, etc.

Terminal and Switching Companies - those companies furnishing both Switching and Terminal services as defined above.

Short Line Railroad - one less than 100 miles in length, located within the United States.

## 3.0 RAILROAD ORGANIZATION

Organization of personnel and delegation of responsibility varies widely with the size of the company and with varying management concepts among companies. However, the following is a typical skeletonized outline of the usual lines of responsibility, with emphasis on operations (see Figure 1).

President or Chief Executive Officer - has overall responsibility for all matters pertaining to the railroad and has a staff comprised of:

- Vice President - Law
- Vice President - Accounting and Finance
- Vice President - Labor Relations and Personnel
- Vice President - Real Estate and Industrial Development
- Vice President - Traffic, responsible for sales and tariff rates
- Vice President - Operations, responsible for all matters pertaining to train operations and for maintenance of track and structures and of mechanical equipment.

The Vice President, Operations - will have a staff of:

- Chief Engineer
- Chief Mechanical Officer
- Superintendent, Transportation
- General Superintendent, (Train Operations).

The General Superintendent - has responsibility for a number

The Vice President, Operations - will have a staff of:

- Chief Engineer
- Chief Mechanical Officer
- Superintendent, Transportation
- General Superintendent, (Train Operations).

The General Superintendent - has responsibility for a number
of Division Superintendents.

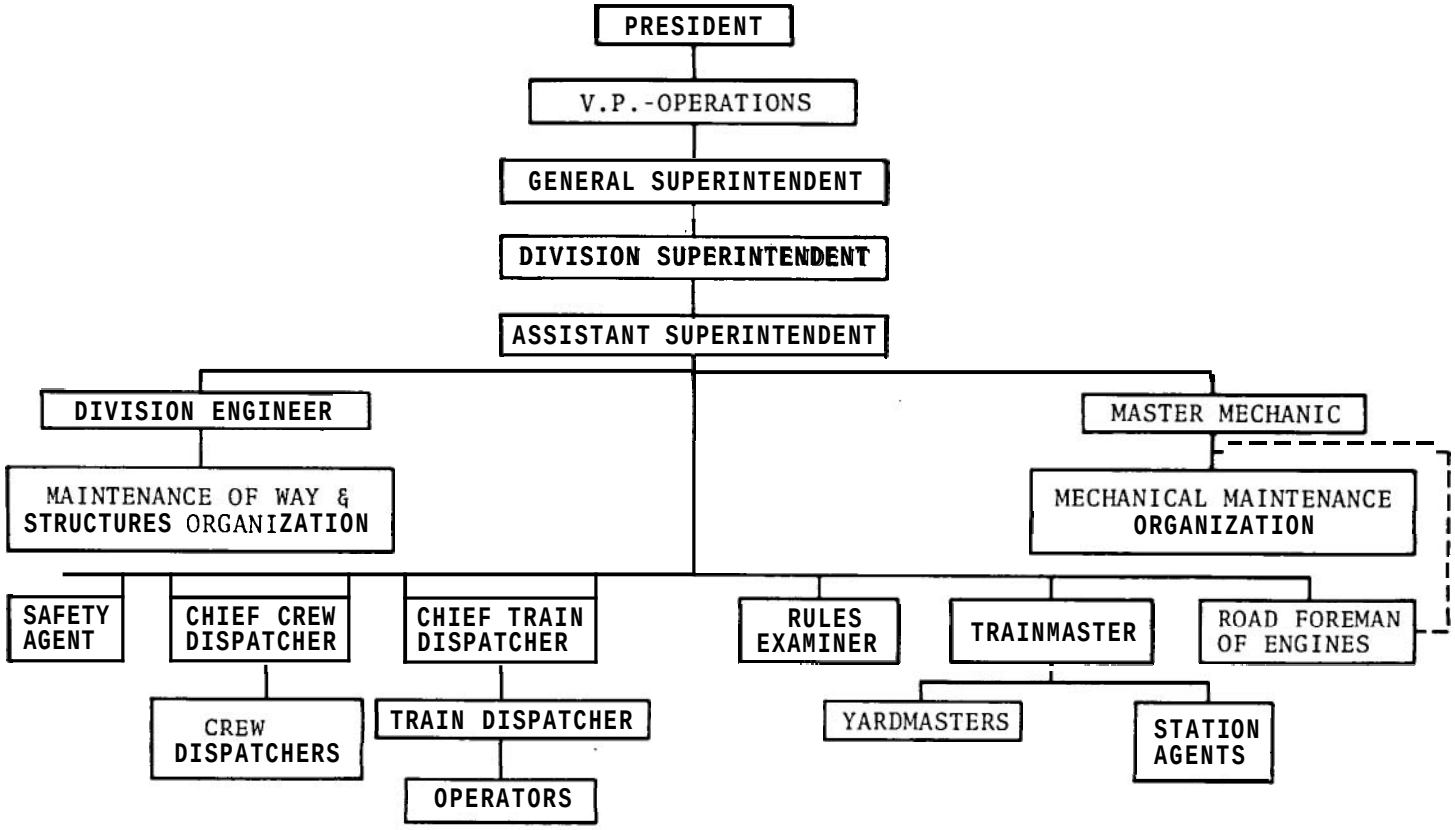


Figure 1. A Skeletonized Typical Organization Chart

Division Engineer, responsible for maintenance of tracks structures, signals, etc., on the Division.

Master Mechanic - responsible for the maintenance of locomotives, cars, and other mechanical equipment while on the Division.

Trainmasters, carrying out the policies and instructions of the Superintendent relating to train and yard operations, and assigned to specific territories within the Division.

Chief Train Dispatcher, is the direct authority for the movement of all trains on the Division, and issues all orders in the name of the Superintendent.

He is responsible for the preparation of all timetable train schedules and must authorize the movement of all trains not scheduled in the timetable, except as otherwise specifically authorized by the operating rules and timetable instructions.

He is assisted by:

Train Dispatchers who are responsible for all train movements on a line, or lines, of railroad having specific limits.

Train Directors, Tower Operators and Operators who are responsible to the Train Dispatcher for all train movements within specific segments of the Train Dispatcher's territory.

Chief Crew Dispatcher is responsible for the proper manning of all trains and switchers with engine crews, (consisting of an engineman plus a fireman if required), train crews, (consisting of a conductor or yard foreman plus generally 2 or more trainmen or brakemen), and the assignment of all other jobs

to be filled by personnel on the rosters of the engine-men, firemen, conductors, trainmen and baggagemen. The Chief Crew Dispatcher and his staff must make assignments in accordance with the manning rules and practices of the Company and in accordance with the current agreements between the Labor Organizations and the company, covering; seniority, assignment to "regular" jobs, 'maintenance of "spare boards" and assignments therefrom, qualifications for the job to be covered, etc. They must maintain daily records for each employee of the job covered and time on duty and time off duty.

Rules Examiner and Staff instruct, examine, and either qualify or disqualify those employees whose duties require them to be familiar with the Book of Operating Rules and the Timetable.

Road Foreman of Engines generally receives assignments from the Superintendent but reports to the Master Mechanic on mechanical matters. He instructs, examines and qualifies or disqualifies enginemen on the book of Air Brake Rules, in the operation of engines and in the handling of trains of various consists over the road.

Such examination will include written and/or oral tests and a sufficient number of field trips with the candidate to know that he can properly handle engines and trains.

He will also examine the candidate on the physical characteristics of the lines of railroad over which he is to operate, before the candidate is qualified.

He also instructs enginemen in the handling of new equipment.

Safety Agent. On Sizeable railroads a director of safety will be assisted by safety agents working at the division level whose duties will include:

1. Conducting periodic safety meetings with operating and maintenance personnel.
2. Periodic inspection of the property with respect to safety and fire protection.
3. Assisting in the investigation of train derailments, personal injuries, etc. and preparing reports as required by regulatory bodies and railroad officers.
4. Liaison with the safety section of the A.A.R.
5. Maintenance of a call list of companies especially equipped and available to handle potentially hazardous lading in case of an accident involving such lading.

## 4.0 REGULATORY BODIES

Regulation of railroads is carried on at both the State and Federal level. Federal regulation of railroads engaged in interstate commerce applies to the following areas:

1. Accident Reporting
2. Safety Appliances (on rolling stock)
3. Signal systems - design and inspection of
4. Hours of Service
5. Locomotive Inspection
6. Train Brakes - use and inspection of
7. Hazardous Material - handling of

Enforcement of these regulations is carried out by the Federal Railroad Administration of the Department of Transportation. In addition the Federal Railroad Administration has jurisdiction over all areas of railroad safety for all railroads - regardless of whether or not engaged in interstate commerce.

The Interstate Commerce Commission regulates the financial affairs of railroads engaged in interstate commerce such as rates, routes, mergers, holdings, joint operations, reports of physical and financial condition, accounting standards, etc.

Among the Federal Laws governing interstate railroads, the "Sixteen Hour Law" as amended on December 26, 1969, is of particular interest. In summary, this Act as amended, provides that it shall be unlawful:

1. To require or permit an employee engaged in or connected with the movement of any train who has been on duty continuously for fourteen hours, to continue on duty or to go on duty until he has had at least ten consecutive hours off duty, except that effective December 26, 1972 such fourteen hour duty period shall be reduced to twelve hours, or

2. To require or permit an employee to continue on duty or to go on duty when he has not had at least eight consecutive hours off duty during the preceding twenty-four hours.

The Act further provides that:

1. The crews of wreck or relief trains are excepted

2. No train dispatcher, operator, or other employee who dispatches, reports, transmits, receives, or delivers orders pertaining to or affecting train movements -

   a. shall be on duty more than 9 hours in twenty-four hour period where two shifts are employed.

   b. shall be on duty more than twelve hours in a twenty-hour period where one shift is employed.

3. A penalty of $500.00 for each and every violation of this Act.

The provisions of laws and of regulations issued by regulatory bodies concerning operation and maintenance of a railroad are incorporated in the Company's rule books and timetable special instructions when practicable, or covered by issuance of notices to concerned employees.

State regulation is usually in such areas as clearance requirements, grade crossings, fencing, local train service, intrastate service, etc.

Enforcement is by the Department of Public Utilities, Public Utilities Commission, the State Department of Transportation, or other like agencies.

## 5.0 LABOR RELATIONS

Wages, working conditions and disciplinary procedures are governed by agreements between the labor organizations representing the many different crafts of workers, and the railroad management. On a major railroad there may be twenty, or more, organizations each bargaining separately with the management.

While an agreement on major issues may be negotiated on a rational level between one organization and a committee representing all, or most, or the railroads, there may be a wide variation in the terms of agreements concerning less important matters from one railroad to another.

While there are generally basic agreements between each of the labor organizations and a railroad management, the provisions of these agreements are undergoing constant change as a result of: the adoption of new technology, new interpretations of the contracts arrived at in settlement of disputes, changing conditions.

The manning of trains and yard switchers may be in accordance with:

1. Company policy, considering the work to be done and requirements for safe operation.
2. Agreement with the labor organizations.
3. The dictates of Federal or State Laws, or of court decisions.

The basic engine crew of both road freight trains and yard switchers consists of an engineman (engineer) and may, or may not, include a fireman.

The basic road freight train crew consists of a conductor and two brakemen; however, in some States three brakemen are required by law. One of the brakemen, (termed the "head end man"), rides on the engine while the conductor and one or more brakemen ride in the "cabin car" or "caboose" at the rear end of the train.

The basic train crew used in freight or yard switching service consists of a conductor and one or more brakemen. One of the brakemen, termed the "head end man," rides on the engine in road freight service while the conductor and the additional brakeman ride in the "cabin car" or "caboose[1] at the rear end of the train.

In train and yard service:

1. The engine crew will earn one day's pay:
   a. For 100 miles run, or less, or
   b. For 8 hours, or less, of time on duty.
2. The train crew will earn one day's pay:
   a. For each 150 miles run, or less, or
   b. For 8 hours, or less, of time on duty.

NOTE

These provisions are currently undergoing changes so that a day's pay more nearly represents 8 hours work, regardless of miles run.

## 6.0 AUTOMATIC SIGNALS

While the company's book of operating rules generally illustrates and defines the various signal aspects and the type of signals in use on the property, some additional explanation will assist in understanding the signal system and the operating rules.

Automatic block and approach signals are spaced a sufficient distance apart to permit the reduction of the speed of a train to that called for by the advance signal aspect before the next signal is reached.

Automatic signals and automatic highway protective devices are activated when the metal wheels and axles of a rail unit make a connection between the rails of the track conducting a very weak electrical current. The shunting of the track circuits operates relays to activate the signals. Since relatively light units of railroad equipment cannot be depended upon to operate the signals, such units may only occupy the track with the permission of the dispatcher in accordance with the book of operating rules.

## 7.0 TRAIN BRAKE SYSTEM

Probably the most critical skill the engineman exercises in train handling is the control of train speed through the judicious use of the several braking systems available to him. Although the details of the air brake system, with its numerous modes of operation, safeguards, and other characteristics, are complex, the system is based on a relatively simple elementary design, diagrammed in Figure 2. As long as critical pressure is maintained in the brake pipe, control valves remain closed, excluding compressed air from the brake cylinders and thus allowing the springs in the brake cylinders to hold the brake shoes free of the wheels. When brake pipe pressure is reduced, either by venting it through the manual operation of a brake valve handle or through any accidental breakage of the pipe, the control valves open, allowing compressed air to enter the brake cylinders from the auxiliary reservoirs, forcing the brake shoes against the wheels and braking the train. Such a system is "fail-safe", since almost any accident to the system is more likely to cause the brakes to apply than to release. The following material shows how this elementary design has been applied to the complex air brake systems of locomotives and freight cars, together with hand brakes and dynamic braking, to provide the engineman with a versatile system for controlling train speed.

Freight train brake equipment includes:

1. A Hand Brake on each unit of equipment, which must be applied and released manually.

2. The Automatic Air Brake Equipment on locomotives and cars in the train, controlled by the engineman through operation of the automatic *brake valve handle* in the locomotive, to simultaneously apply or release the brakes on both the locomotive and cars.

   Operation of the air brakes on the locomotive alone may be controlled by use of the independent brake *valve* handle,

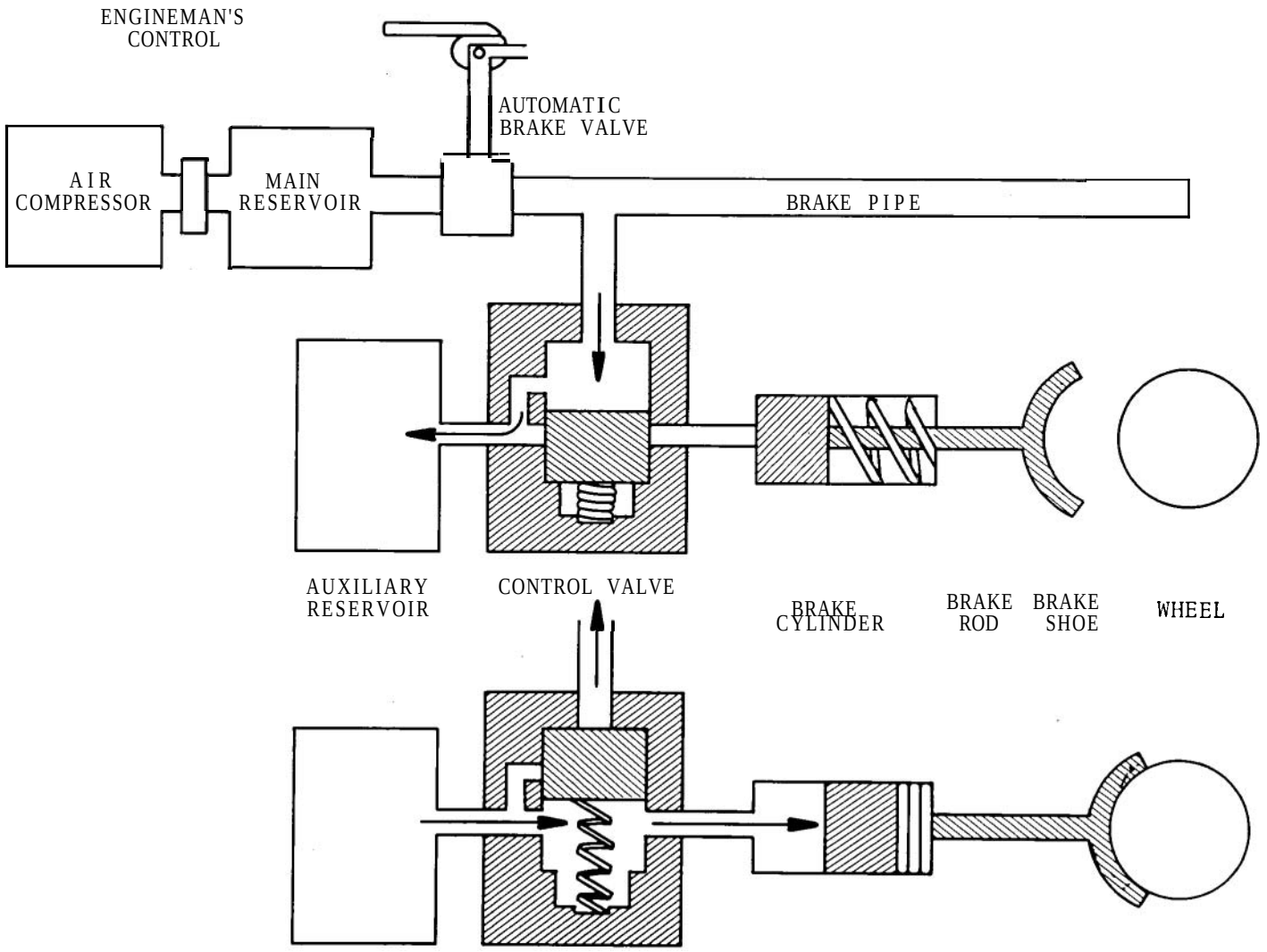


**Figure 2. Elements of Railroad Air Brake Systems**

which may also be used to nullify an application of the *locomotive* brakes initiated by operation of the automatic brake valve handle.

3. Dynamic Brake Equipment on the locomotive electrically converts some of the power developed by the momentum of the moving locomotive into an effective retarding force, applicable to the locomotive only.

**NOTE**

Both air brakes and dynamic brakes may be used by the engineman, either separately or in conjunction with each other, to control the speed of the train.

# 8.0 AUTOMATIC AIR BRAKE EQUIPMENT

## 8.1 LOCOMOTIVE AIR BRAKE COMPONENTS (Figure 3)

### 8.1.1 Air Compressors

Air Compressors (air cooled or water cooled) supply air at about 140 psi to the first main reservoir. Air from the first main reservoir flows to:

1. The main reservoir equalizing pipe which connects with the first main reservoirs of other locomotive units coupled in the engine consist.
2. The second main reservoir through a check valve which insures a volume of air stored specifically for use in the locomotive brake cylinders and in the train brake system.

From the second main reservoir air flows to the automatic brake valve at the engineman's controls through a filter and moisture trap. In Figure 3 the automatic brake valve is shown as "26-C Brake Valve", which is also shown in Figure 4. As the air enters the locomotive system it is reduced from 140 psi to about 80 psi through a regulating valve known as a feed valve which can be adjusted to provide the exact pressure required by the train brake system.

### 8.1.2 Automatic Brake Valve (Figures 4 and 5)

A manually operated device mounted at the engineman's controls which can be positioned to:

1. Direct the flow of air from the main reservoir to an auxiliary reservoir on the locomotive for storage for use in operation of the locomotive brakes and at the same time direct air to the locomotive brake pipe, until feed valve pressure is reached.
2. Maintain feed valve pressure in the reservoirs and brake pipe system.

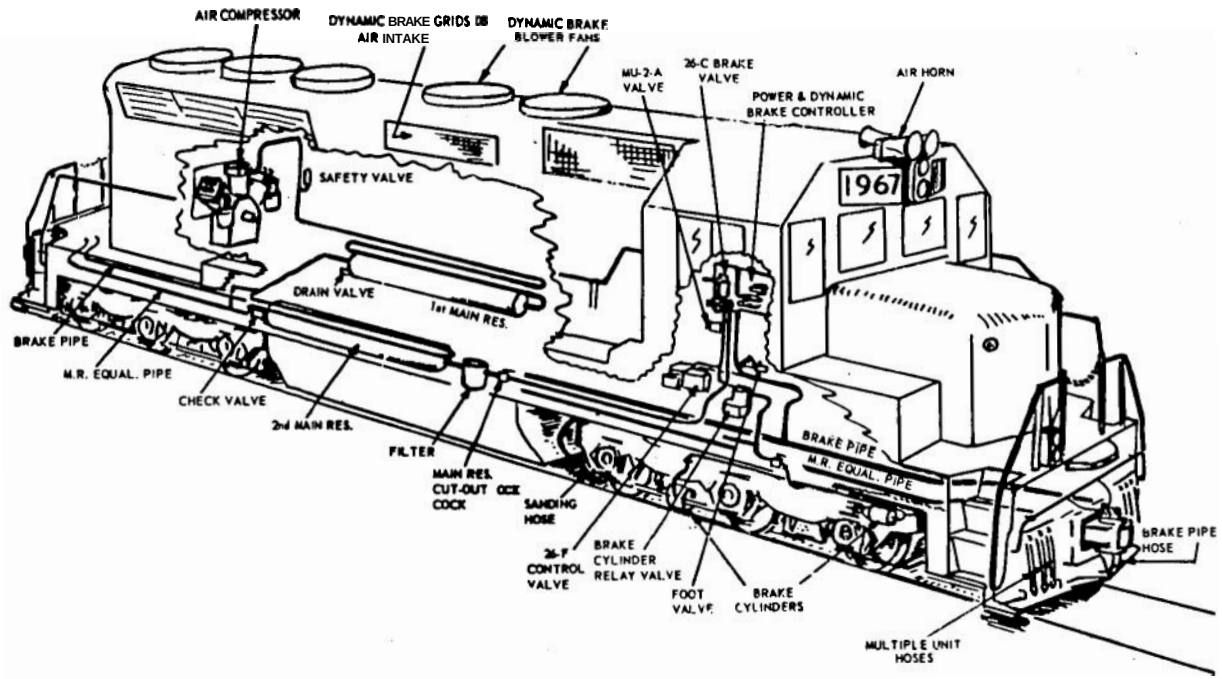


Figure 3. Typical Arrangement of Locomotive Air Brake Components

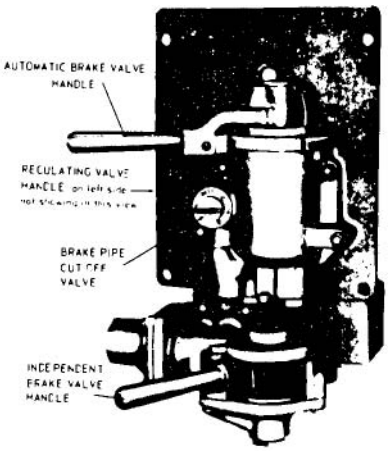


Figure 4. 26-C Automatic Brake Valve

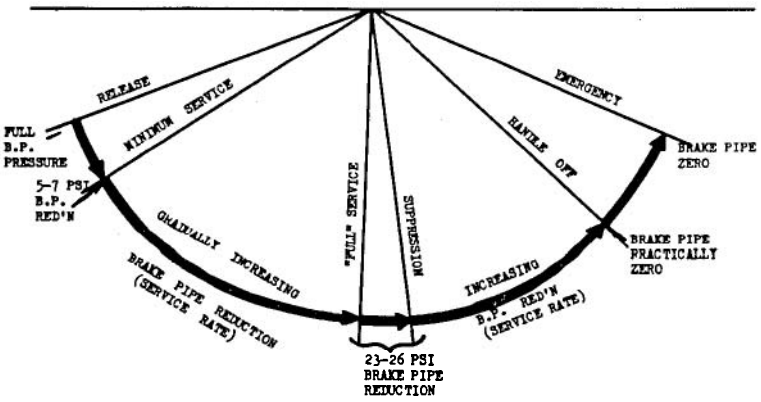


Figure 5. 26-C Automatic Brake Valve Handle Positions

3. Provide a controlled graduated reduction in air pressure, (called a "service reduction"), in the brake pipe causing brakes to apply on the locomotives and cars in the train.

4. Provide a fast reduction to zero air pressure in the brake pipe, (called an "emergency reduction"), causing the brakes on the locomotives and cars to apply with maximum speed and force.

8.1.3 Brake Pipe

The pipe on the locomotive which is connected through flexible hoses to the brake pipe on each car in the train, and provided with angle cocks, through which air is directed to or from the components of the automatic air brake equipment of the cars in the train.

8.1.4 Control Valve

A valve which moves in response to a differential in the air pressure to:

1. Exclude air from the brake cylinder port and direct it to the auxiliary reservoir. (Automatic brake valve handle in "release" or running position.)

2. Direct air from the auxiliary reservoir to the brake cylinder, causing the brakes to apply. (Automatic brake valve handle in service position.)

8.1.5 Brake Cylinder

Figure 2 illustrates the principles of the locomotive brake cylinder in which air from the auxiliary reservoir acts against a spring-loaded piston, causing the brakes to apply. A typical brake cylinder is shown at the bottom of Figure 6.

**NOTE**

While these definitions and the attendant illustrations generally describe the principal elements of the locomotive air brake system, a total control

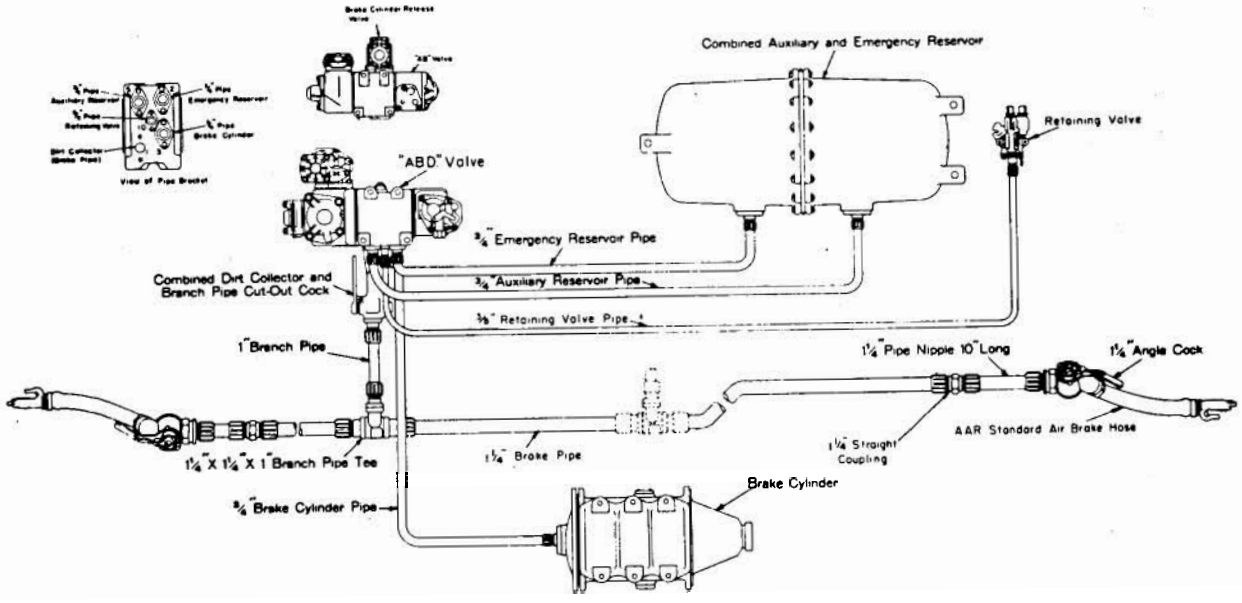


Figure 6. Typical AB Type Freight Car Equipment

system is a very complex arrangement of pipes, valves, cocks, reservoirs and gauges.

8.1.6 Multiple Unit Operation

(Commonly referred to as M.U.) Two or more locomotives, properly equipped for multiple unit operation, may be operated as one "engine" of a train, by an engineman located in the lead locomotive of the engine consist. When M.U. controls are properly positioned on "lead" and "trailing" units, the power, dynamic brake and automatic air brake systems on the trailing units will respond automatically to the movements of the control levers on the leading unit.

8.1.7 Freight Car Automatic Air Brake Components (Figures 6, 7, 8)

1. The emergency air reservoir and the auxiliary air reservoir are separated, although contained in one unit.

2. The brake cylinder contains a piston connected to the brake rigging, shown in Figure 8. When sufficient air is admitted to the brake cylinder the piston moves against the pressure of a coiled spring anchored at the conical end inside the cylinder, to apply the car brakes through the system of levers, comprising the brake rigging. When air is exhausted from the brake cylinder the coiled spring returns the piston to its rest position thereby causing the car brakes to be released.

3. The retaining valve (Figure 6) is mounted in the air exhaust pipe of the control valve and is usually set for "full exhaust", but in certain extreme grade situations it may be manually set to retain up to 20 psi in the brake cylinder when the automatic brake valve handle at the locomotive is in "release" position and the train brake system is being recharged.

4. Control Valve. Either the AB or ABD control valve, (similar in principle), is generally in service on freight

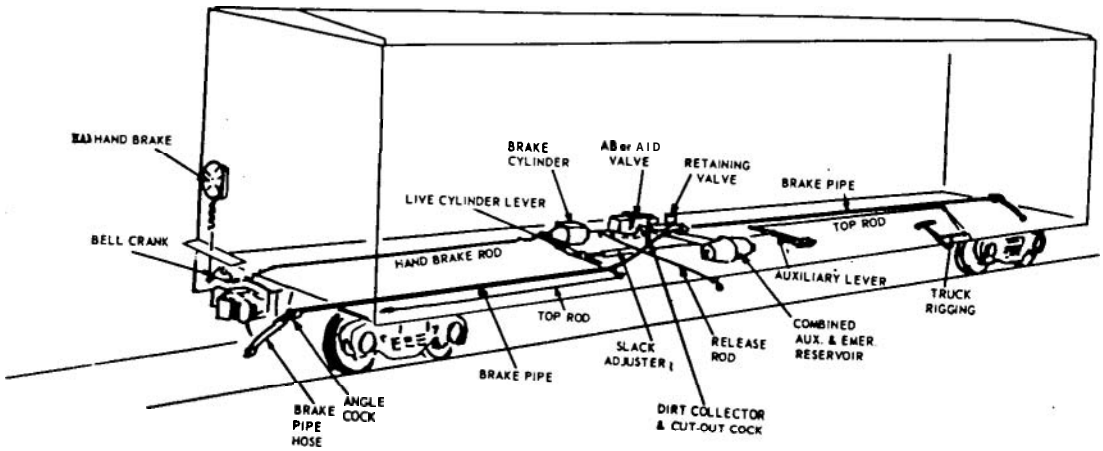


Figure 7. Typical Arrangement of Brake Equipment on a Freight Car

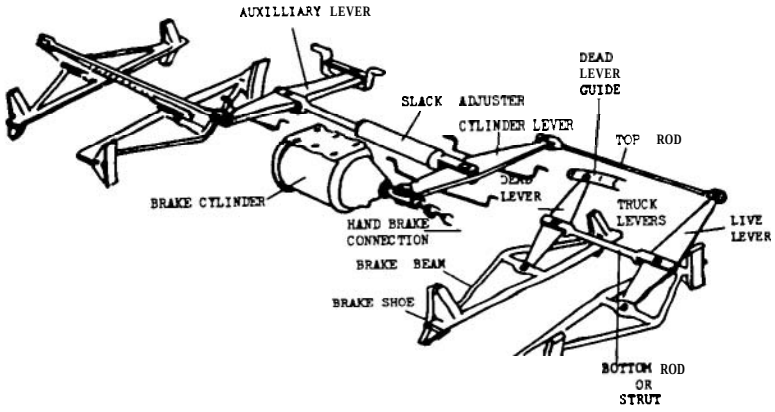


Figure 8. Conventional Brake Rigging Body Mounted Cylinder

car equipments in present day use (see Figure 6). The valve has three essential portions.

a. The pipe bracket, which is bolted to the car underframing, and to which is bolted the service portion and the emergency portion of the control valve and a brake cylinder release valve. The pipe bracket is connected to the brake pipe through the branch pipe and combined dirt collector and cut-out-cock. The bracket also has pipe connections to the brake cylinder, emergency reservoir, and auxiliary reservoir as well as a pipe, on which is mounted the retainer valve, to exhaust air to the atmosphere. Various internal passages direct air to and from the service and emergency portions of the valve and to the AB Brake Cylinder release valve.

b. The service portion controls, either directly or through the medium of the emergency portion, the desired charging of the service reservoir and the emergency reservoir and controls the "service application of the brakes. This is accomplished through the action of a spring loaded slide valve, graduating valve, checks and chokes which are activated and controlled by an applied differential of air pressure, to open or close the proper internal ports and air passages of the valve,

c. The emergency portion provides quick action and controlled high brake cylinder pressure. This is accomplished through the action of valves and checks which starts when the differential air pressure between the air reservoirs and the brake pipe reaches emergency proportions by venting air from the valve directly to the atmosphere and by directing air from both service and emergency reservoirs to the brake cylinder. The valve provides fast recharging of the storage and emergency reservoirs and release of the brakes.

5. Release Values at the AB and ABD valve provide for manually bleeding the air from:

   a. The car brake cylinder alone. (This is generally necessary before classifying cars.)

   b. The car storage and emergency reservoirs.

6. Cut-out Cock is used to isolate or "cut-out" the automatic air brake equipment of a car in a train without affecting the brake pipe pressure control to other cars in the train. When this is done the cut-out cock on the car is closed; the brake cylinder and the service and emergency reservoirs of the car are manually drained of air.

7. Brake Pipe (Figure 6) carries air for the operation of the cars' automatic air brake equipment and is connected to the locomotive air brake pipe and to brake pipes of the following cars to form a continuous train line from the locomotive to'the last car in the train.

8.1.8 Operation: Case I

With the automatic and independent brake valve handles in "release" or "running" position, (Figure 5):

1. The locomotive control valve permits air to enter the auxiliary reservoir of the locomotive for storage.

2. Air enters the brake pipe and flows to the car control valve, (AB or ABD), where the slide valves are activated by air pressure to direct the flow of air to the auxiliary and emergency reservoirs while excluding air from the brake cylinders which are connected to exhaust through the control valve, and the car brakes remain in a released position.

3. The locomotive and car brakes are held in a released position by the control valves so long as the brake pipe air is held at the required pressure (about 80 psi usually).

8.1.9 Operation: Case II

With the automatic brake valve in service position, (Figure 5), ranging from minimum service to "full service", brake pipe pressure is reduced by an amount determined by the position of the automatic brake valve handle with the following results:

1. The pressure differential between the locomotive auxiliary reservoir and the brake pipe causes the control valve to direct air from the auxiliary reservoir to the locomotive brake cylinders producing a brake application at a pressure dependent upon the amount of brake pipe pressure reduction.

2. The pressure differential between the auxiliary reservoir on the car and the brake pipe causes the slide valve in the service portion of the car control valve to move to a position directing air from the auxiliary reservoir to the brake cylinder, producing a brake application at a pressure dependent upon the amount of brake pipe pressure reduction. Air in the emergency reservoir is not utilized in this service application but is retained for emergency use. When the automatic brake valve handle is returned to release position, brake pipe pressure is increased and the locomotive and car control valves move to direct air:

   a. From the brake cylinder to exhaust, releasing the brakes.

   b. From the brake pipe to the auxiliary reservoirs.

   c. From car emergency reservoir to the car auxiliary reservoir, until the pressure in the brake pipe and reservoirs again equal feed valve pressure.

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   a. From the brake cylinder to exhaust, releasing the brakes.

   b. From the brake pipe to the auxiliary reservoirs.

   c. From car emergency reservoir to the car auxiliary reservoir, until the pressure in the brake pipe and reservoirs again equal feed valve pressure.

1. Apply the locomotive brakes with maximum force.
2. Apply the car brakes with a maximum force, utilizing air from both the auxiliary and emergency reservoirs.

NOTE

The same action results when brake pipe pressure is reduced to zero for any reason such as an emergency application from the conductor's or fireman's valve, or a broken pipe or hose in the air brake system.

# 9.0 LOCOMOTIVE EQUIPMENT CLASSIFICATION

## 9.1 DIESEL ELECTRIC LOCOMOTIVE

This constitutes by far the most numerous group of locomotives in use in this country today. The present builders of these locomotives in the United States are:

1. The Electromotive Division of the General Motors Corp., commonly referred to as "EMD".
2. The General Electric Co., commonly referred to as "GE".

One of the principal builders of locomotives in the past was the American Locomotive Co., whose units are referred to as "ALCO" locomotives. Many of these units are still in service throughout the country.

Locomotives are generally further classified according to the intended use:

### 9.1.1 Passenger

Equipped to handle passenger trains.

### 9.1.2 Freight

Equipped for freight work and further classified as:

1. Road Freight. Capable of handling thru freight trains and ranging from about 1500 H.P. up.
2. Road Switchers, Used primarily in local freight service, and ranging from about 1200 to 1500 H.P.
3. Yard Switchers, ranging from less than 600 H.P. to about 1200 H.P., or more.

### 9.1.3 General Purpose

Equipped for use in either Passenger or Freight service; the designation is "GP".

## 9.2 ELECTRIC LOCOMOTIVES

Designed for use in the electrified zones of certain railroads such as the former New Haven Railroad from New Haven to New York City and the former Pennsylvania Railroad from New York City to Washington, both of which lines are now included in the Penn-Central System.

## 9.3 RAIL DIESEL CARS ("RDC")

These are diesel powered passenger cars equipped to run as single units, or they may be run as multiple units in a train with the power and braking equipment of all cars controlled from the leading unit. Since the Budd Company was the principal builder, they are commonly designated as "Budd Cars".

## 9.4 REMOTE LOCOMOTIVE (or "Slave" Locomotive)

This is a unit placed 1/2 or 2/3 of the distance between the head and rear ends of the train or at the rear. The locomotive functions of the slave unit, (throttle, dynamic brake, automatic and independent air brake, and sanding), are controlled by the engineman on a properly equipped head unit of the head end engine consist through coded space radio. The remote unit provides additional power, faster and smoother application of the air brakes and faster release of the brakes of a long freight train.

## 10.0 TYPES OF LOCOMOTIVE SERVICE

In addition to the types of service previously defined, (passenger train, thru freight train, local freight train, transfer train and yard switching), the locomotive engineman may be called upon to perform the following types of service:

### 10.1 HUMP OPERATION

Requires the locomotive engineer to push a string of cars over a hump lead at a steady rate of speed and slowly enough so that the cars may be manually uncoupled at the hump crest. Some locomotives are equipped with a "hump control" which may be set to control the speed automatically.

### 10.2 PUSHER SERVICE

An operation conducted under company rules wherein one or more locomotives are coupled to the rear end of a train to provide additional power over a segment of railroad with heavy grades - also known as "helper service".

### 10.3 PILOT SERVICE

When the assigned engineman of a train is not qualified over territory to be covered, a "pilot" who is qualified on the physical characteristics is assigned. This happens when the train of a foreign line is detoured over a line of the home railroad, for example.

### 10.4 WRECK TRAIN

This service requires moving a rail mounted crane of up to 250 tons capacity plus cars especially stocked with emergency material to the scene of a derailment.. Time table instructions generally

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cover the movement of such trains. Work at the scene of a de-

10.5 HOSTLER SERVICE

A qualified engineman is used to move locomotives within designated enginehouse territory or within defined terminal limits, as required for servicing, repairs, or storage.

10.6 WORK TRAIN AND SNOW PLOW

This service at the direction of Maintenance of Way forces may be required.

# 11.0 DIESEL ELECTRIC LOCOMOTIVE CONTROL EQUIPMENT

## 11.1 BASIC CONTROLS ON A DIESEL ELECTRIC LOCOMOTIVE ARE:

### 11.1.1 Throttle Lever

Controls the speed of the diesel engine and the main electric generator, supplying electrical power to the traction motors which are geared to the locomotive axles. The throttle lever has the following positions: stop, idle, and running speeds, 1 to 8, or more.

### 11.1.2 Reverse Lever

The reverse lever has three positions; forward, reverse and neutral. The reverse lever must be moved only when locomotive is standing still; it may be removed from the control stand when the lever is in neutral position, thus locking the locomotive operating controls.

### 11.1.3 Automatic Brake Valve

The functions of this valve are discussed in the section dealing with the automatic air brake equipment.

### 11.1.4 Independent Brake Valve

This valve is used to apply and release the locomotive air brakes independently of the automatic brake valve control, discussed under the section dealing with the train brake system.

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## 11.2 BASIC AIR GAUGES ARE:

### 11.2.1 A Duplex Air Gauge

locomotive, which should register about the same as the brake pipe pressure indicator.

### 11.2.2 A Second Duplex Air Gauge

A second duplex air gauge, with differently colored pointers which indicate:

a. Air pressure in the brake pipe.
b. Air pressure in the locomotive brake cylinders.

## 11.3 THE LOAD INDICATING METER

The load indicating meter indicates the load on the traction motors as measured in amperes. The dial of this meter is colored to show when the traction motors of the locomotive are overloaded and the engineman must handle the throttle accordingly.

## 11.4 THE SAFETY CONTROL FOOT PEDAL

The safety control foot pedal, ("dead man control"), provides automatic train brake application if the engineman does not keep the foot pedal depressed during operation; often referred to as a penalty application of the brakes.

## 11.5 MISCELLANEOUS EQUIPMENT INCLUDES:

### 11.5.1 Sanding Valve

Opens a port to supply air for the application of sand to the rails to increase adhesion when starting a train or during a braking operation.

### 11.5.2 Speedometer

The speedometer equipment may also include a device for producing a permanent speed record on tape.

### 11.5.3 Windshield

11.5.4 Horn Valves

Horns, generally located on the front and rear of the locomotive, are air operated.

11.5.5 Locomotive Bell

Locomotive bell is operated by an air valve.

11.5.6 Cab Heaters

11.5.7 Classification Lights

Classification lights, at the front and rear of the locomotive, are provided with interchangeable colored lenses.

11.5.8 Diesel Engine Start and Stop Buttons and Isolation Switch

Diesel Engine start and stop buttons and isolation switch, with two positions:

1. Start - To be used when starting or stopping the power plant.
2. Run - In this position the power plant is connected to the control circuit.

11.5.9 Miscellaneous Electrical and Other Controls

NOTE

The foregoing generally includes the basic equipment necessary to control the operation of a diesel electric locomotive. The control levers, gauges, etc., may be located in different positions in the cabs of locomotives produced by different builders and in dif-

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## 11.6 ADDITIONAL EQUIPMENT

In addition to the basic controls and equipment additional items may include:

### 11.6.1 Dynamic Brake

When a locomotive is equipped to utilize the traction motors for dynamic braking, (see train brake system), suitable controls are provided.

### 11.6.2 Multiple Uniting

If locomotives are equipped for multiple unit operation, equipment is provided to assure automatic response of the controls of the trailing units to the operation of those in the lead unit of the engine consist.

### 11.6.3 Cab Signal System

This system, activated electronically by wayside equipment, provides for the display of wayside signal indications in the locomotive cab, and a warning whistle which sounds following signal changes to a more restrictive indication until the engineman operates an acknowledging device.

### 11.6.4 Automatic Stop

In addition to cab signals, this system provides for an automatic brake application unless the engineman acknowledges the signal change within a fixed time.

### 11.6.5 Speed Control System

A system which provides a penalty application of the train brakes on failure to acknowledge a change of cab signal, or if the speed permitted by the cab signal indication is exceeded.

### 11.6.6 Additional Duplex Air Pressure Gauge

An additional duplex air pressure gauge is provided for use

with systems such as Automatic Stop, Speed Control, etc. to show:

1. Pressure supplied to control valves of these devices, which should be main reservoir pressure.
2. Suppression pressure.

## 12.0 YARD OPERATION

The following series of operations is typically involved in car handling at a major yard equipped with a gravity hump:

1. An inbound train is yarded on a receiving track.
2. The road engine is detached and taken to the engine house.
3. A yard switcher detaches the caboose.
4. Car inspectors go over the entire train marking any defective cars to go to the "cripple track", and recording the reporting marks of those cars. At the same time, the inspectors will bleed the air from the brake cylinders of all cars.
5. A hump list is transmitted to the retarder tower and to the hump conductor showing the classification track number to which each car is destined.
6. The entire train is shoved over the hump and the cars classified into groups according to destination.
7. Blocks of cars are pulled from the classification tracks and set on the departure track to make up an outbound train.
8. Hoses are coupled, yard air is attached and the entire train is inspected.
9. The road engine is coupled to the head end and the caboose to the rear end to complete the train.
10. On proper signal, the engineman makes the required tests for air leakage and to see that all brakes on the train apply and release properly.
11. Upon satisfactory completion of the tests, the yardmaster, or train conductor, informs the dispatcher that the train is ready to depart.

12. When the dispatcher can take the train on the main line, switches will be properly lined and signals will display an aspect permitting the train to proceed.

# 13.0 FREIGHT TRAIN HANDLING

## 13.1 BASIC CONTROLS FOR HANDLING FREIGHT TRAINS POWERED BY DIESEL ELECTRIC LOCOMOTIVES

1. Reverse lever
2. Throttle designed to provide specific horsepower outputs in each position
3. Automatic brake valve handle
4. Independent brake valve handle
5. Selector lever to provide dynamic braking

## 13.2 BASIC INSTRUMENTS BY WHICH THE ENGINEMAN IS GUIDED

1. Load meter
2. Gauges indicating air pressures in the various components.

## 13.3 BASIC CONSIDERATIONS

1. A service brake pipe air pressure reduction produces a brake cylinder pressure in cars and locomotives approximately 2 1/2 times the amount of the reduction. With an initial brake pipe pressure of 80 psi, a maximum service reduction of 23 psi produces a brake cylinder equalization pressure of 57 psi; further reductions in the service zone of the automatic brake valve handle will produce no increase in brake cylinder pressure until the handle is placed in emergency. An emergency application from an initial brake pressure of 80 psi produces a brake cylinder pressure of 69 psi.
2. There is a serial action from the head end to the rear end of the train when the air brakes are applied or released.
3. The train brakes will be released only when the automatic air brake handle is in "release" or "running" position. The locomotive air brakes may be released independently

of the train brakes by depressing the handle of the independent brake valve.

4. The retarding force of dynamic braking applies only to the engine consist leaving the cars in the train free to "bunch", or run in against the engine unless the cars are controlled with the automatic brake; the same condition obtains when the locomotive brakes are applied by use of the independent brake only.

## 13.4 SLACK ACTION

A major factor in freight train handling is slack action, due to the "play" between couplers and in the draft gear at each end of a freight car. The slack, or free movement of cars within a train, between the front and rear ends may total as much as 50 feet for a 100 car train. Slack action within a train, or within a part of a train, may occur when:

1. Starting
2. Stopping
3. Ascending or descending grades
4. The independent brake is applied harshly
5. A quick hard application of the dynamic brake is made
6. Accelerating or decelerating

Since impacts between freight cars at speeds exceeding the equivalent of four miles per hour may cause damage to lading or equipment, slack action must be controlled by proper use of the throttle and train brakes.

The company's book of air brake rules generally prescribes procedures for train handling in various situations.

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# 14.0 TRAIN ENGINEMAN

## 14.1 TRAINING AND QUALIFYING

An employee may become an engineman qualified to operate trains by:

1. Passing a physical examination
2. Working in locomotive service the required length of time
3. Attending required training programs
4. Passing field tests and written or oral examinations covering:
   a. The company's book of operating rules and timetable instructions
   b. Operation of air brake and air signal equipment on cars and locomotives
   c. Operation of electrical and mechanical equipment on locomotives, and the associated controls
   d. Proper methods of operating locomotives and handling trains under various conditions
   e. Physical characteristics of the lines of railroad over which he is to be qualified to operate

Once qualified, an engineman will not ordinarily be required to requalify unless he has failed to fill a locomotive assignment for a specific period. Employees in locomotive service will be instructed in the use of new equipment and may be required to pass an examination on it. Enginemen who have not run over a line of railroad within a specified period of time will be re-examined on the characteristics of that line before being allowed to operate an engine over it without a pilot.

## 14.2 DESCRIPTION OF DUTIES

### 14.2.1 General

In considering a job dcecription for the train engineman

there are several variable factors and conditions to be taken into account. Among these variables are:

1. Type of locomotive service to be performed
2. Number, type and horsepower ratings of the locomotives in the engine consist
3. The number and types of electrical, mechanical, and pneumatic controls with which the engine consist is equipped
4. Length and tonnage of the train to be handled
5. Location of loaded and empty cars within the train, which will have an effect on slack action
6. Weather conditions
   a. Cold weather may increase brake pipe leakage to the point where the number of cars in a thru freight train will have to be substantially reduced below normal.
   b. Wet rails may reduce adhesion, which increases the tendency for wheel slipping or sliding to occur, thus reducing the effective tractive effort and braking capacity.
7. Characteristics of various lines of railroad with respect to:
   a. Location and severity of grades and curves
   b. Location and type of signals controlling train operation,
   c. Speed restrictions
   d. Highway grade crossings

Since operation of a through freight train with a multiple unit engine consist comprised of diesel-electric locomotives is probably the most representative of the demands on the skills and training of the engineman, this tentative job description is outlined on that basis. This analysis will be general in character, since company rules and instructions usually specify the inspections to be made and the procedures to be followed by the engineman in various situations.

### 14.2.2 Preliminary Duties

Preliminary duties will include a check of the bulletin board for notices and orders, as well as signing the register.

### 14.2.3 Locomotive Inspection at Initial Terminal

The engineman must know that:

1. All units have sufficient fuel.
2. There is no apparent leakage of fuel, lubricating oil, water or air.
3. Proper brake pipe and multiple uniting hose connections are made between units, after condensate has been blown out.
4. Proper positioning of all cut out cocks, angle cocks, and valves.
5. Moisture has been drained from main reservoirs, and automatic drain valves are operative.
6. The condition of brake shoes and rigging is satisfactory.
7. Air compressor is operating satisfactorily and has sufficient lubricating oil.
8. There is sufficient engine cooling water.
9. Hand brakes are released on trailing units.
10. Lead locomotive is secured during brake test.
11. Hoses not in use are properly retained.
12. Handles and valves at the operating station of the leading unit and the trailing units are properly positioned.
13. Air pressure control devices are functioning properly.

### 14.2.4 Starting Diesel Engine

With isolation switch at "start", throttle lever at "idle", and reverse lever at "off", close fuel pump switch. Check to see

that fuel is being delivered to engine. Operate starting control. Make applicable inspections after engine has started.

14.2.5 Locomotive Air Brake Tests at Initial Terminal

1. Know that brakes apply and release in response to operation of independent brake valve handle.
2. Check responses to operation of automatic brake valve handle.
3. Test for brake pipe leakage; not to exceed three pounds per minute after a service reduction of ten pounds with the automatic brake valve handle.
4. Check brake cylinder piston travel.

14.2.6 Coupling

The engine consist to the first car of the train must be accomplished with cars to avoid excessive impact. After engine brake pipe is blown out and brake pipe hoses coupled, angle cocks between engine and car must be opened slowly. Where practicable the entire train should be stretched to see that all couplings are made.

14.2.7 Initial Terminal Test of Train Air Brakes

When the engine is used to charge the train air brake system, the indgpendent brake will remain applied. While the train air brake system is being charged from the engine, the train may be inspected to assure proper hose couplings, positioning of angle and cut-out cocks, and for air leaks. When aaboose air gauge shows a specified pressure (15 pounds below feed valve pressure, usually), trainman will signal engineman to test brakes. Engineman will make a 15 pound brake pipe reduction with the automatic brake

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vayle *handle.* Engineman *will then-* 30 seconds **after the** brake pipe

all brakes have applied, piston travel is correct, and brake rigging is in proper condition. On proper signal, engineman will release the brakes and the train is again inspected to see that all brakes have released.

Use of yard air and suitable equipment to charge the train line and inspection of the cars before the engine is coupled on expedite departure.

### 14.2.8 Starting Train

Time must be allowed for the brakes to release after a full service application. With reverse lever in "forward" and automatic and independent brake valve handles in "release" or "run" positions, throttle should be advanced slowly. After starting, throttle should not be advanced while amperage shown by the loadmeter is increasing. Engineman will be guided by loadmeter, speedometer, and wayside signals. If necessary to advance throttle to third or fourth notch to start train, throttle should be reduced after starting to allow slack to adjust. Caboose crew should advise when caboose is in motion. Engineman must watch wheel slip light.

### 14.2.9 Starting Train on a Descending Grade

Independent brake may be used to control speed of locomotives until whole train is started and slack is adjusted.

### 14.2.10 Starting Train with Use of Slack

If necessary to take the slack to start the train, engineman will back gently into the train, then maintain a slow forward speed of one to two miles per hour until the whole train is moving.

### 14.2.11 Starting Train on Ascending Grade

It may be necessary to use the following method:

1. Make a sufficient service brake reduction to hold the train on the grade.
2. Back gently into the train, bunching the slack, until the rear car moves, then continue the reduction until the train stalls.

3. Apply independent brake before closing the throttle and make a further reduction of ten pounds with the automatic brake.

4. Close throttle.

5. Position reverser for forward movement.

6. Release brakes, open throttle and move slowly. Control speed of locomotive with throttle and independent brake until the whole train is moving. Watch for wheel slip.

14.2.12 Braking Train to a Stop with Power Applied

When this is desirable, the engineman will:

1. Make one service brake application consisting of two or more reductions.

2. Make an initial reduction of not less than six pounds nor more than fifteen pounds. Locomotive brake must not be allowed to apply.

3. After brake pipe exhaust of initial reduction ceases; close throttle gradually maintaining a moderate pulling amperage.

4. Close throttle and make final reduction so that brake pipe exhaust is open as train comes to rest.

14.2.13 Braking to Slow Train with Power Applied

To accomplish this the engineman will:

1. Make an initial service reduction of not less than six pounds.

2. Keep locomotive brake released on all service brake reductions.

exhaust is open as train comes to rest.

14.2.13 Braking to Slow Train with Power Applied

To accomplish this the engineman will:

1. Make an initial service reduction of not less than six pounds.

2. Keep locomotive brake released on all service brake reductions.

14.2.14 Braking Train to a Stop with Power Off

The engineman will:

1. Make one service brake application consisting of two or more reductions, after the throttle has been gradually reduced to "idle", and the slack has been gathered by use of the dynamic or independent brake.
2. Make an initial service brake reduction of a minimum of six pounds.
3. Make the final reduction so that the brake pipe exhaust is open as the train comes to rest.

14.2.15 Braking to Slow Train with Power Off

The engineman will:

1. Gradually reduce throttle to idle.
2. Gather slack with dynamic brake or independent brake.
3. Make a service brake reduction of six pounds or more.
4. Make further light reductions, as required, in small increments.
5. Make a service brake reduction of at least 12 pounds before returning brake valve handle to "run" position, or "release".

14.2.16 Dynamic Braking

Dynamic braking, if available, may be used to help control train speed either alone or in conjunction with the train air brakes. When used, engineman will:

1. Reduce throttle to idle gradually.
2. Move selector level to dynamic brake position.
3. Watch loadmeter and speedometer as braking power is applied.
4. Reverse the procedure when dynamic braking is no longer required.

14.2.17 At Final Terminal

At final terminal the cars of the train will be left on designated receiving tracks, the locomotive detached and left on a designated storage track in accordance with company instructions. Engineman will record required repairs to locomotives on a prescribed form and register off duty.