Inspection and Basic Maintenance of Brake Systems
Types

- Air brakes
- Hydraulic brakes
- Secondary braking systems
Air Brake System

- Most large, modern fire apparatus are equipped with air-operated braking systems
- Three braking systems combined
  - Service
  - Parking
  - Emergency
Air Brake System

- **Air compressor**
  - Pumps air into the air storage tanks (reservoirs)

- **Governor**
  - Controls when the air compressor will pump air into the air storage tanks
Air Brake System

- Air storage tanks
  - Hold compressed air
    - Allow brakes to be used even if compressor stops working
  - Checked daily for condensation
  - Number and size varies
Air Brake System

- Air dryer
  - Collects and removes contaminants
  - Provides clean, dry air
  - In line between the air compressor and first air storage tank
Air Brake System

- **Alcohol evaporator**
  - Reduces the risk of ice in air brake components during cold weather

- **Treadle valve or master control valve**
  - Located at the brake pedal
  - Controls entire brake system
  - Overrides other components
Air Brake System

- Safety relief valve
  - Installed in the first tank the air compressor pumps air into
  - Protects the tank and the rest of the system from too much air pressure
Air Brake System

- **Brake pedal**
  - Brakes are applied by pushing down on the brake pedal
  - Also called the foot valve or treadle valve
Air Brake System

- **Brake chamber**
  - Converts the energy of compressed air into mechanical force and motion

- **Slack adjuster**
  - The link between the brake chamber and the foundation brake camshaft
Air Brake System

- Drums and shoes
- Discs and pads
- Types
  - S-cam
  - Wedge
  - Disc
S-Cam

Wedge
How a Disc Brake Works

- Caliper
- Piston
- Brake Pads
- Rotor
- Hub
- Wheel attaches here
Air Brake System

- One-way check valve
  - Allows air to flow in one direction only
  - All vehicles with air brakes must have a check valve located between the air compressor and the first reservoir
Air Brake System

- Air supply pressure gauge
  - All air-braked vehicles have an air supply pressure gauge connected to the air tank
  - Dual air brake system
Air Brake System

- **Application pressure gauge**
  - Indicates how much air pressure you are applying to the brakes

- **Low air pressure warning**
  - Required with air brakes
Air Brake System

- **Air pressure protection valve**
  - Prevents air horns/air adjuncts from operating when the pressure in the air reservoir drops below 80 psi

- **Stop light switch**
  - Turns on the brake lights when you apply the air brakes
  - Does with an electric switch that works by air pressure
Air Brake System

- Front brake limiting valve
  - Some apparatus made before 1975
  - Normal position
  - Slippery position
Air Brake System

- Spring brakes
  - Meets emergency and parking brake requirements
  - When driving, powerful springs are held back by air pressure
  - Parking brake must be held on by mechanical force
Air Brake System

- Dual air brake systems
  - Used for safety
  - Operated by a single set of brake controls
  - The first system is the primary system
  - Other system is the secondary system
Air Brake System

- **Antilocking brake systems (ABS)**
  - On most newer apparatus
  - Reduces possibility of being thrown into a skid when the brakes are fully applied

- **Components**
  - Speed sensors

- **Valves**
  - In the brake line of each brake controlled by the ABS
  - On some systems, the valve has three positions
Air Brake System

- **Pump**
  - Restores pressure to the brakes once released by the valves

- **Controller**
  - A computer in the car that watches the speed sensors and controls the valves
Brake System Components

- Drum Brakes
- Pedal
- Booster
- Master Cylinder
- Combo Valve
- Emergency Brake
- Lines
- Disc Brakes
Hydraulic Brake System

- **Master cylinder**
  - Acts as the holding tank for brake fluid
  - When the brake pedal is depressed, the master cylinder forces fluid to each of the wheels
Master Cylinder
Hydraulic Brake System

- Combination valves
  - Ensures that the front and rear brake systems are working together
  - Consists of a
    - Metering valve
    - Proportioning valve
    - Brake warning light
Combination Valve
Hydraulic Brake System

- Brake pedal
- Brake lines
- Wheel cylinders
  - Contains fluid-activated pistons that push the brake shoes/pads against the drums/discs
Drum Brake

- Brake Cylinder
- Pistons
- Drum
- Cable
- Emergency Brake Lever
- Adjuster Mechanism
- Brake Shoes
- Emergency Brake Mechanism
Hydraulic Brake System

- Emergency brakes
  - Manually operated
  - Not dependant on the hydraulic system
Hydraulic Brake System

- The operational principles of drum brakes/shoes, and the disc brakes/pads are the same as with air brakes
Drum Brakes
Secondary Brake Systems

- Saves wear on the primary brakes
- Referred to as retarders
- Retarders employ many existing apparatus components
  - Optimized control through the use of rotating engine and drive train forces
Secondary Brake Systems

- Engine retarders
  - Compression brake
    - Uses engine to brake
    - Turns engine into energy absorbing air compressor
  - Exhaust brake
    - Uses exhaust from engine to brake
    - Works opposite compression brake
Secondary Brake Systems

- **Automatic transmission retarder**
  - Works with gear selection
  - Empty chamber mounted to rear of transmission
  - Transmission pump forces fluid into chamber
    - Chamber automatically empties
      - When not in use

- **Driveline**
  - Magnetic field developed with battery voltage
Inspection & Basic Maintenance

Air Brakes

- Air brake tests - DMV
- Air compressor and governor
  - Air pressure should build to allow apparatus operations within 60 seconds of starting
  - Need to be operationally tested daily
Air Brakes

- Air storage and drain tanks
  - Proper mounting
  - Loose
  - Clean
  - Drain daily
Inspection & Basic Maintenance

Air Brakes

- Air dryer and alcohol evaporator
  - Securely mounted
  - Connections intact

- Safety valve
  - If the safety valve releases air, something is wrong
Inspection & Basic Maintenance

Air Brakes

- Slack adjusters
  - Look for
    - Broken, loose, and missing parts
    - Proper angle between push rod and adjuster arm
      - A little over 90° when brakes released and,
      - Not less than 90° when applied
Inspection & Basic Maintenance

Air Brakes

- Brake pedal
  - Firm when applied
  - Not continue to travel to the floor when pressure is applied
  - Securely mounted
  - Operating properly
Inspection & Basic Maintenance

Air Brakes

- Brake drums & shoes/discs & pads
  - Excessive or uneven wear
  - Missing components
  - Cracks
  - Out of shape
  - Operational failure
  - Falls below required standards
Inspection & Basic Maintenance

Air Brakes

- One-way check valve
  - Check for leaks
  - Securely mounted

- Air supply pressure gauge
  - Must be above 90 psi to operate safely

- Application pressure gauge
  - Proper operation
Air Brakes

- **Low air pressure warning**
  - Activates below 60 psi OR
  - One half the compressor governor cut-out pressure

- **Stop light switch**
  - Operates the brake warning lights
Inspection & Basic Maintenance

Air Brakes

- Front brake limiting valve
  - Leaks
  - Mounting

- Spring brakes
  - Missing components
  - Leaks
Air Brakes

- Dual air brake systems
  - All inspections same as single systems
**Inspection & Basic Maintenance**

**Air Brakes**

- Maintenance should be completed by a qualified technician

  - Due to the complexity of the system and safety issues
Hydraulic Brakes

- Hydraulic brake test
  - Pump brake pedal three times and hold for five seconds
  - Pedal should not move
  - If it does, there is a leak
Inspection & Basic Maintenance

Hydraulic Brakes

- Master cylinder
  - Check fluid level
  - Fill with proper manufacturer's recommended fluid
  - Cover should not be leaking fluid
  - Inspect for leaks
  - Wear may cause cylinder to leak
  - May result in brake failure
Hydraulic Brakes

- Brake pedal
  - Firm when applied
  - Not continue to travel to the floor when pressure is applied
  - Securely mounted
  - Operating properly
Inspection & Basic Maintenance

Hydraulic Brakes

- Brake drums & shoes/discs & pads
  - Excessive or uneven wear
  - Missing components
  - Cracks
  - Out of shape
  - Operational failure
  - Falls below required standards
Inspection & Basic Maintenance

Hydraulic Brakes

- Brake lines
  - Physical damage
  - Leaking fluid

- Wheel cylinders
  - Leaking fluid
  - Sticking wheel cylinder can cause brake to drag
Inspection & Basic Maintenance

Hydraulic Brakes

- Brake linings
  - Same as air brake systems
Inspection & Basic Maintenance

Hydraulic Brakes

- Maintenance should be completed by a qualified technician
  ⌛ Due to the complexity of the system and safety issues
Secondary Brakes

- Inspections should include
  - Proper mounting
  - Loose or missing components
  - Physical damage
  - Leaks (if applicable)

- Most failures are discovered during operational tests
Secondary Brakes

- Maintenance should be completed by a qualified technician

- Due to the complexity of the system and safety issues
NFPA Out-of-service Criteria

Air Brakes

- Service brakes that have a drop of more than 2 psi in one minute
- Leak-down rate (time) is more than 3 psi in one minute
- Brakes out of adjustment
- Defective system components
NFPA Out-of-service Criteria

Air Brakes

- Ineffective braking operation
- Ineffective parking brake
- Air compressor that fails to build air pressure
- Air compressor that fails to maintain 80-90 psi pressure in the system
NFPA Out-of-service Criteria

Air Brakes

- Friction surfaces, brake shoes, or disc brakes with grease or oil
- Lining, pads, rotors, or drums worn beyond manufacturer's minimum specifications
- Activated ABS warning indicator
NFPA Out-of-service Criteria

Hydraulic Brakes

- Components with a Class 2 leakage or are defective
- Friction surfaces, brake shoes, or disc brake pads with grease or oil
- Ineffective braking or parking brake operation
NFPA Out-of-service Criteria

Hydraulic Brakes

- Warning light activated or pedal that falls away/drifts when brake pressure applied
- Lining, pads, rotors, or drums worn beyond manufacturer's minimum specifications
- Activated ABS warning indicator
NFPA Out-of-service Criteria

Secondary Braking Systems

- None stated
CCDH Out-of-service Criteria

- **Air brakes**
  - Only indicates driving test failure, not out-of-service criteria

- **Hydraulic brakes**
  - If fails DMV hydraulic brake test

- **Secondary braking systems**
  - None stated