EMERGENCY VEHICLE OPERATOR

Module 2
Major Vehicle Systems
Pre-trip Inspections

Revised 9/1/2021
OBJECTIVES

• Identify the major vehicle systems and their component parts
• Determine methods and requirements for pre-trip inspection of vehicle systems
• Define maintenance requirements for vehicle systems
• Review MCFRS out-of-service criteria for fire department apparatus
• Review defect reporting and resources for apparatus operators
Motivation

Why Know the Components?

- Correctly identify defects and write accurate defect reports
- Determine and differentiate between normal, monitoring, and out of service conditions
- Identify critical safety issues before they cause injury or damage
- Ability to communicate with mechanics when describing conditions – “speaking their language”
- Make educated decisions about the vehicle you are driving!
Definitions
MCFRS OOS Criteria

• Leakage
  o Class 1: seepage of fluid; not enough to form drops
  o Class 2: leakage great enough to form drops; drops do not drip
  o Class 3: leakage great enough for drops to drip

• Operational Test: A test to determine the operational readiness of a component on a fire apparatus by observing the actual operation of the component.
Vehicle Data Plate

• Each apparatus should have a manufacturer’s data plate in the cab
• Information may differ from the information found on the chassis data plate on the door frame
  o Manufacturer’s data plate reflects final completed “as built” vehicle
  o Chassis data plate reflects just the chassis information prior to body installation or customization
• Use the manufacturer’s plate as the reference for the finished vehicle
There are five primary vehicle systems that impact your ability to safely control the apparatus:

1. Tires
2. Wheels
3. Steering
4. Suspension
5. Brakes
TIRES

• Key to all vehicle movement
  o Steering
  o Braking
  o Accelerating

• CID
  o Condition
  o Inflation
  o Depth
WHEELS
ALUMINUM OR STEEL

- Valve stem
- Lugs
- Hub
WHEELS
AESTHETIC COVERS

• Economical alternative to aluminum wheels
• Covers installed over steel wheels or old aluminum wheels
  o Hook onto hand holds
• Covers bear NONE of the load
• Hide corrosion, damage, leaking hubs, or defects in the load-bearing component of the wheel
• Obscures hub oil window
STEERING SYSTEM

Cotter pin

Castle nut

Steering arm

Steering wheel & shaft

Tie Rod

Lower steering arm

Upper steering arm

Power steering pump

Gear Box

Pitman arm

Drag link
SUSPENSION

• Everything that connects the body and accessories to the wheels
  o Frame
  o Body mounts
  o Springs
  o Shock absorbers
  o Axles

• Enables the vehicle to adjust to imperfect travel surfaces
  o Improves handling
  o Improves passenger comfort
  o Reduces wear on the body and accessories
  o Constantly under stress and load
Front Suspension

- Shock
- Rubber Bushing
- Axle
- U-Bolt
- Spring
- Front shackle
- Rear shackle
Rear Suspension

- Air Bags
- Torsion Bar
- Rear Axle
- U Bolts
SUSPENSION
WEIGHT RATINGS

• Gross Vehicle Weight Rating (GVWR)
  o includes curb weight, additional equipment that's been added, the weight of cargo and the weight of passengers
  o Maximum total weight vehicle may ever be

• Curb Weight
  o Includes all vehicle components without passengers or cargo
**Brake Systems**

- Generate friction at the wheels to slow or stop the vehicle
  - Energy of movement is converted to heat energy
- MCFR EMS Units after 2010 have hydraulic brake systems with air actuated parking brakes
  - May find air brakes on EMS Units, however not common
  - Air systems present for rear suspension and parking brake
Anti-lock Braking Systems

• Anti-lock braking systems use electronic sensors that control the mechanical application of force at the wheels
  o Generates micro-pulses in the brake activation
  o Senses wheel rotation speed to identify when lock-up is occurring
  o If ABS fails, the brake system reverts to a traditional system solely dependent upon the driver inputs

• Primary components:
  o Electronic Control Unit: the brain of the ABS
  o Exciter or Pulse Ring: attached to the axle or wheel hub turning at the same speed as the wheel
  o Wheel Speed Sensor: a small induction coil mounted in close proximity to the pulse ring
ANTI-Lock Brake Systems
BRAKE SYSTEMS
DISC BRAKES

- Sheds debris, water, etc.
- Pads wear evenly
- Self cleaning
- Dissipate heat
- Visual inspection without disassembly
**Brake Systems**

**Drum Brakes**

- Traps debris, water, etc.
- Wears unevenly
- Builds up dirt
- Retain heat – brake fade
- Difficult to inspect without disassembling

So, why use them?

✓ Cheaper to manufacture
✓ Lower maintenance frequency
✓ Require less hydraulic force to actuate
BRAKE SYSTEMS
DISC VS DRUM

TYPES OF BRAKES

DISK BRAKE
- splash shield
- brake line
- disk
- stud
- piston
- wheel hub
- brake pads

DRUM BRAKE
- drum
- brake lining
- return spring
- piston
- wheel cylinder
- brake shoe

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**Brake Systems**

**Hydraulic**

- Hydraulic systems use fluid to translate pressure from the brake pedal to the brakes at the wheels.
- Master cylinder converts mechanical pressure of the brake pedal into hydraulic pressure.

[Image of hydraulic braking system]

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Hydraulic Braking System
Parking – Spring Brake

Parking Brake Applied

1. A large spring pushes against a plate
2. It moves the pushrod out
3. Pushes on the slack adjuster
4. Turns the S Cam
5. Pushes the brake shoes against the brake drum

Parking Brake Released

1. Air pressure pushes the spring back
2. The pushrod moves back
3. The slack adjuster moves back
4. The S Cam turns
5. Brake shoes move away from the brake drum, releasing the brakes
AIR BRAKES
DOT INSPECTION

• Conducted in a specific sequence
  o Ensures all critical features are checked properly

• Incorrect sequence
  o Does not check operation of the system sufficiently
  o Will result in a failure during candidate exams - PAGS

• Requires a watch, phone, or other means to keep time

• Ensures the air compressor, sensors, system leakage, and safety features are within specification
  o COLA acronym

• Full Air Brake Test is included in EVO Class B
AIR BRAKES
C-O-L-A

C=Cut in Pressure
• Indicates compressor is engaging properly

O=Cut out Pressure
• Indicates governor is working properly and compressor is disengaging properly

L=Low Pressure warning
• Verifying that the low air alarms are functioning

A=Air Leakage rate
• Assessing the ability of the entire system to hold air
**Auxiliary Braking Systems**

**Exhaust Brakes**

- Closes off the exhaust path
- Creates back pressure in the motor
- Reverses the natural flow of the motor to slow the motor
- Generate less slowing than an engine brake
- Usually found on smaller diesel vehicles
  - 2016 EMS Units
Drive Shaft

Carrier Bearing

U-Joint

Pumpkin

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PRE-TRIP INSPECTION
PRE-TRIP INSPECTION

1. Review defect records
2. Vehicle overview
3. Walk around check
4. Engine compartment
5. Interior cab
6. Undercarriage check
7. Compartment equipment check
8. Motor started/operations check
9. Complete documentation
PREPARATION

• Pass along from prior shift
• Obtain pre-trip equipment
  o Creeper, flashlight, rag or paper towel, note pad
  o Eye protection, gloves
• Circle check
• Has the unit recently been run?
  o Beware hot components
• Determine a suitable location
• Wheel chock placed
ENGINE COMPARTMENT

- Hood cables
- Radiator & Overflow
- Alternator
- Air conditioner compressor(s)
- Air filter & restriction gauge
- Fan
- Belts & Hoses

- Power steering pump
- Air compressor
- Steering shaft, box, linkage
- Lower steering components
- Front suspension
- Fluids
  - Motor oil
  - Transmission fluid
  - Power steering fluid
  - Coolant
OOS Criteria – Engine Compt

- Air filter restriction indicator that shows maximum restriction after resetting
- Engine system that has significant leakage of oil
- Oil that contains coolant
- Oil that is diluted with fuel
- A fuel system component that has Class 2 leakage of fuel

- Cooling system component that has Class 3 leakage
- Coolant that contains oil
- Radiator that is loose
- Cooling fan that is loose or cracked
- Transmission fluid that contains engine coolant
**Interior Cab**

- Instrument Panel
- Accelerator
- Conduct Air Brake Test
- Check Steering Wheel
- Seat, mirror, and steering wheel adjustment
- Switch panels
- Automatic snow chains
- Transmission fluid
- Windshield
- Heat / air conditioning
- Defroster
- Radio/Computer Equipment
- Interior/Exterior Lighting
- Mirrors
- Occupant Restraints
- Vehicle registration and insurance card
- DOT inspection certificate

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EVOC - Module 2
TRANSMISSION SELECTOR

• All frontline apparatus have automatic transmissions
• Note the absence of “P”
  o Park in “N”
  o Pull the parking brake
• Generally no reason to use the up/down arrows during travel
OOS CRITERIA – INTERIOR CAB

- Defective or damaged driver’s or officer’s seatbelt
  - Must be enough functioning belts for each crew member
- Cracked or broken windshield that obstructs the driver’s/operator’s view
- Missing or broken mirrors that obstruct the driver’s/operator’s view
- Windshield wipers that are missing or inoperable
- Steering wheel that has a deficiency affecting the drivability of the vehicle
- Door latches that are defective
- Defrosters that are inoperable
- Accelerator that is inoperable or defective
- Oil pressure, engine, and/or transmission temperatures that can not be monitored or verified
- Engine or Transmission that is overheating
- “Stop-engine” warning light that remains illuminated after engine is started
- Speedometer that is inoperable
OOS CRITERIA – INTERIOR CAB

• Automatic transmission that has a “Do not shift” light on
• Charging system that fails to maintain 12-volts
• Air gauge or audio low air warning device that has failed or is inoperable when air pressure < 60psi (vehicles with air brakes)
• ABS warning indicator that is activated. (The warning indicator generally indicates that ABS is inoperable and the vehicle should be driven as such.)
• Brake warning light that is activated or brake pedal that falls away or drifts toward the flooring when brake pressure is applied
• No operable audible DOT warning devices (at least either the electric horn or the air horn, if so equipped, must be operable)
• No operable audible emergency warning devices (at least the electronic siren, or the mechanical siren, if so equipped, must be operable)
UNDERCARRIAGE

- Bleed Moisture From Air Tanks/ Air Brake Systems
- Brake System
- Driveline
- Exhaust System
- Suspension System
- Automatic Chain Systems
- Leaks From Transmission or Axle

- Body mounts
- Rust
- Loose Parts
- Shiny Spots, Cracks
- Inner Sides of Tires and Wheels
- Wiring Harness
- Loose Belts & Hoses
- Fuel Tank
OOS CRITERIA - UNDERCARRIAGE

- Defective body or cab mounts
- Defective suspension components
- Steering components that are defective affecting the vehicle handling
- A steering component that has Class 3 leakage
- Driveline components that are defective

- Axle flanges that have Class 3 leakage
- Exhaust components are broken or hanging
- Exhaust components are leaking causing exhaust fumes to enter the cab or patient compartment
OOS Criteria - Undercarriage

- Tires that have cuts in the sidewall that penetrate to the cord
- Any tire that is flat or has a detectable or audible leak
- On dual wheel tires: tires that are touching sidewall to sidewall when properly inflated
- Wheels that are cracked, bent, and/or broken that affect drivability

- Fuel tank, mountings, or straps that are defective
- Transmission components that have Class 3 leakage of transmission oil
- Braking system components that are defective
- Brake system components that have Class 2 leakage of brake fluid
- Friction surfaces, brake shoes, or disc brake pads that have grease or oil on them
EXTERIOR BODY & COMPARTMENTS

- Battery box & Batteries
- Fuel Tank
- DEF tank
- Shoreline connection
- DOT lights
- Warning lights
- Tires and wheels
- Exhaust pipe

- Compartment latching
- Inventory
- Spare electrical fuses
- Flares or warning triangles
- Wheel chock
- PPE
- SCBA
- Specialty equipment
- Fire extinguisher
OOS CRITERIA – EXTERIOR

- Door latches that are defective
- Tires that have cuts in the sidewall that penetrate to the cord
- Tires that have a tread depth of $4/32”$ or less on any steering axle at any two adjacent major tread grooves anywhere on the tire
- Tires that have a tread depth of $2/32”$ or less on any non-steering axle at any two adjacent major tread grooves anywhere on the tire
- Any tire that is flat or has a detectable or audible leak
- On dual wheel tires: tires that are touching sidewall to sidewall when properly inflated
- Wheel studs missing or loose wheel lugs
- Wheels that are cracked, bent, and/or broken that affect drivability
- An axle with a hub seal that has any Class 3 leakage or an empty reservoir
- Fuel cap is missing or does not seal to prevent spillage
OPERATIONAL CHECK

- Circle Check
- Remove Wheel Chocks, Charging Cords
- Transmission In Neutral / Park
- Parking brake engaged
- Batteries & Ignition on / Allow Gauge Sweep
- Start Motor
- Check Gauges
- View DOT and warning lights
- Air system
OOS Criteria – Operational Check

- Braking operation that is ineffective
- Parking brake operation that is ineffective
- Insufficient DOT lighting to clearly mark the vehicle
- Insufficient warning lighting to clearly indicate emergency response
- Turn-signal is Inoperable
- Air compressor that fails to build or maintain air pressure.
SHUTTING DOWN APPARATUS

• A hot engine should be allowed to idle for a couple of minutes prior to shut down, i.e. following a response
• Engine and turbo temperatures increase upon shutdown since oil and air are no longer circulating
• Results in damage over time to internal engine components and turbo seals
ENGINE AFfERTREATMENT

• Enables compliance with EPA emissions standards – emergency vehicles are NOT exempt

• After 2006, all diesel exhaust systems have a particulate filter and associated regeneration system
  o Diesel Particulate Filter (DPF) captures soot and ash
  o Regeneration burns off the soot and ash that accumulates

• After 2009, aftertreatment systems include Diesel Exhaust Fluid (DEF) for additional treatment of exhaust gases

• There are two operator interventions necessary with these systems:
  o Active Regeneration – aka “parked” regeneration
  o Refilling the DEF tank

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DIESEL PARTICULATE FILTER
HOW DOES IT WORK?
**Diesel Particulate Filter Indicator Lamps**

**Aftertreatment Diesel Particulate Filter**
- Indicates a regeneration is needed – passive or active
- When flashing, regeneration is more urgently needed

**High Exhaust System Temperature**
- Does not signify any need for service – regeneration occurs at high temperatures
- Keep the exhaust pipe outlet away from combustibles

**Flashing DPF Light + Check Engine**
- Regeneration is needed immediately
- Active regeneration is required
DIESEL PARTICULATE FILTER
PASSIVE REGENERATION

• Occurs automatically as needed when driving over 40mph
  o Does not require any action on the part of the driver
• Primarily designed to address over-the-road trucks that travel at high speeds for long periods
• It is unlikely that MCFRS apparatus will drive enough highway miles for Passive Regeneration to complete its cycle
1. DPF lamp illuminates or flashes
2. Determine a suitable location to park the apparatus
   o Away from combustibles or items that could be damaged by exhaust heat – need at least 5 feet of clearance
   o Outdoors and NOT connected to the PlymoVent
3. After parking the unit, engage the manual regeneration
   o May be a toggle switch, rocker switch, or other control
   o Motor rpm should increase to approximately 1100rpm.
4. The driver must remain with the vehicle during regeneration
   o Duration varies by amount of soot in the DPF – 5 to 20 minutes
**DIESEL PARTICULATE FILTER**

**ACTIVE REGENERATION – “PARKED REGEN”**

- Regeneration will stop:
  - Automatically when the motor controls sense the particulate filter is cleaned
  - Manually if the brake pedal is depressed
- Unit may remain *in service* during regen
- Regen will not interfere with other vehicle functions, i.e. pump, PTO, hydraulics
- Vehicle exhaust components will remain very hot following the regen process
  - High temperature light will illuminate
Regen Switch Example – 2016 EMS Unit
**Diesel Exhaust Fluid (DEF)**

**What is it & What does it do?**

- Non-hazardous solution of 32.5% urea and 67.5% de-ionized water used in post-2009 diesel vehicles
- DEF is sprayed into the exhaust stream of diesel vehicles to break down NOx emissions into nitrogen and water
- DEF is **not a fuel additive** and never comes into contact with diesel
- DEF is stored in a separate tank, typically with a blue filler cap.
DEF Tank gauge located above fuel gauge on dash.

DEF Tank located rear of the batteries on the driver’s side of the unit.
**Diesel Exhaust Fluid Contamination – Fuel vs. DEF**

- **Nozzle sizes**
  - DEF nozzles are 0.75"; diesel nozzles are 0.87"
  - The diesel nozzle should not fit into the DEF tank
  - The cap for the DEF tank is blue and will be clearly marked

- **Diesel in the DEF tank**
  - Diesel will float on top of DEF
  - Small amounts of diesel can damage the exhaust system
  - If any fluid except DEF is poured into the DEF tank, contact CMF immediately and do not drive the vehicle.

- **DEF in the fuel tank**
  - The motor will stop running almost immediately, and the vehicle will require repair
**Diesel Exhaust Fluid Supply, Handling, and Refill**

- Stocked in 2.5 gallon containers with filler tubes or in bulk drums at select stations
  - requested as needed through normal supply procedures
- DEF crystallizes when stored for prolonged periods as the water evaporates
  - Do not use DEF that shows signs of crystallization
  - Always completely use a container to avoid storing opened containers
- Refill when the level indicator reaches 1/2 or less
  - The tank should accept one full 2.5 gallon container of DEF
  - No need to continuously top off the DEF tank
- Filler tube is supplied with the case
- Spills can be safely washed down with water. DEF is not corrosive to human skin, however is corrosive to aluminum. Do not allow it to remain on the diamond tread.
- The freezing point of DEF is 12°F, however vehicles are equipped to thaw the DEF and this should not restrict use of the vehicle.
- Personal protective equipment is not necessary when handling DEF, however it will stain clothes.
DEFECT REPORTING
FLEET MANAGEMENT REPORTING SYSTEM

• Requires employee ID # and password
  o Not the same as single sign-in or network info
• Statistics are required to complete the online report
  o Vehicle mileage
  o Engine Hours
  o Pump Hours
  o Generator Hours
• Enter only one defect per report
  o Provide a detailed description of the issue
  o Include photos when applicable
• Permits the operator to see what defects exist and who reported them when
ADDITIONAL RESOURCES

• MCFRS Operator’s Guide to Fire Apparatus Out of Service Criteria

• PSTA Driver Training Website

• MCFRS Apparatus Checkout Form

• Pre-trip Inspection Self-Study Guide
  o https://www.montgomerycountymd.gov/mcfrs-psta/Resources/Files/Driver/class%20materials/EVOC/Summer%202019%20update/Pre-Trip%20Study%20Guide.pdf
QUESTIONS?

End of Session 2