Learning Objective 1

Distinguish among preperformance tests for pumping apparatus.
Pumping apparatus must undergo tests to ensure that the pump and powertrain will perform as specified under normal use.
Fire department personnel may be involved in some apparatus testing.

- Manufacturers’ and certification tests:
  - Manufacturer
  - Underwriters Laboratories

- Acceptance tests:
  - Fire department personnel, especially driver/operators
Manufacturers are required to perform additional tests if bid specifications include requirements of NFPA® 1901.

Road test

Hydrostatic test
Road tests are conducted to make sure that apparatus meet the many standards set forth by NFPA® 1901.

- Conducted with vehicle loaded to same weight as it will be when placed in service
- Testing area location must not violate laws or motor vehicle codes
- Roads must be flat, paved, dry, and in good condition
- Apparatus must meet minimum standards
- Other tests specified by jurisdiction may be added
Hydrostatic tests ensure that the pump and associated piping can withstand high pressure pumping demands.

- Pump body, entire intake and discharge piping system are tested
- Tank fill and tank-to-pump lines on tank side of valves are an exception
- Subjected to minimum hydrostatic test pressure of 500 psi (3 500 kPa) for minimum of 10 minutes
Pump certification tests are performed by independent testing organizations.

**Pump certification tests**

- Designed to ensure fire pump will operate as designed on completed apparatus
- Performed at manufacturing plant before final acceptance
- Results stamped on plate affixed to pump panel
- Requirements should be part of bid specifications
Specific tests are required for apparatus with a fire pump of 750 gpm (3,000 L/min) up to 3,000 gpm (12,000 L/min).

<table>
<thead>
<tr>
<th>Engine speed check</th>
<th>Pumping test</th>
<th>Pumping engine overload test</th>
<th>Pressure control system test</th>
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<tbody>
<tr>
<td>Priming system test</td>
<td>Vacuum test</td>
<td>Water tank-to-pump test</td>
<td>Engine speed interlock test</td>
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<tr>
<td>Gauge and flowmeter test</td>
<td>Manufacturer’s predelivery test</td>
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Acceptance testing is conducted to demonstrate that the apparatus conforms to all bid specifications at time of delivery.

Acceptance testing

- Conducted at jurisdiction
- Should feature pump test in addition to pump certification test previously performed at the factory
- Apparatus that fails to perform should be rejected by purchaser
- Pumping engine overload test should be conducted in jurisdictions higher than 2,000 feet (600 m) above sea level
What is the difference between manufacturers’ tests, certification tests, and acceptance tests?
Learning Objective 2

Summarize facts about performance testing of fire pumps.
Pumpers must be tested

- At least once each year
- After undergoing major pump or powertrain repair

Pumper performance testing ensures

- The pump will perform as designed
- Any defects will be noticed and repaired before the apparatus is placed in service
The following tests are included in the performance testing of fire pumps.

- Engine speed check
- Pump shift indicator
- Pump engine control interlock
- Priming system test
- Vacuum test
- Pumping test for fire pumps
- Overload test
- Pressure control test for fire pumps
- Intake relief valve system test
- Gauge test flowmeter test
- Tank-to-pump flow rate
Many jurisdictions prefer drafting from a static water source to conduct pumper performance tests.

Considerations when drafting from a static source:

- Water level
- Air temperature
- Water temperature
- Barometric pressure
- Use minimum intake hose arrangements
- Sufficient number of discharge hoses
Net pump discharge pressure is the difference between the intake pressure and the discharge pressure.

Performance tests are conducted at various psi (kPa)

When operating at draft, net pump discharge pressure is more than the pressure displayed on discharge gauge

Friction loss in the intake hose and height of the lift must be considered

NFPA® 1911 provides information on friction loss allowances for intake hose

Friction loss allowances are used to determine correct pump discharge pressure for each test
The following equipment is required for performance tests on fire department pumpers.

- Gauge to determine intake pressure
- Gauge to determine pump discharge
- Pitot tube if flowmeter is not used

(Cont.)
The following equipment is required for performance tests on fire department pumpers.

- Smooth bore nozzles of appropriate size
- Means to secure nozzles (rope, chain, or test stand)
- Hand tachometer (if applicable)
- Means to record test results
Additional equipment is not required for performance testing, but may make the process easier and more efficient.

- Two 6-foot (2 m) lengths of ¼-inch diameter, 300 psi (2 100 kPa) hose with screw fittings and gauges
- Clamp to hold pitot tube to test nozzle
- Test stand to hold gauges
- Stopwatch
Flowmeters indicate flow in gallons (or liters) per minute within plus or minus five percent of accuracy.

- Offers increased efficiency over pitot gauge when determining flow from nozzles.
- May be conducted without shutting down the pump, changing nozzles, or converting pressure reading of pitot gauge to gallons per minute (L/min).
- Ensure flowmeter has been properly calibrated to manufacturer’s specifications.
Follow these safety guidelines when performing fire pump service testing.

1. Wear protective head gear, eyewear, gloves, and hearing protection.
2. Open and close valves and nozzles slowly.
3. Operate the engine throttle slowly.
4. Secure test nozzles and observe hose from a safe distance.

(Cont.)
Follow these safety guidelines when performing fire pump service testing.

1. Ensure no people or obstructions are in the path of a hose stream.
2. Be sure personnel are protected from open manholes if using a test pit.
3. Chock apparatus wheels.
An engine speed check should be conducted under no-load conditions after checking all fluid levels.

If engine is not running at correct speed (plus or minus 50 rpm)

Apparatus should be evaluated by qualified mechanic before further testing

Engine speed may be determined by engine tachometer and/or properly calibrated handheld tachometer
A vacuum test evaluates the priming device, pump, and intake hose for air leaks.

Many departments perform this test first.

Pump fails to reach 22 inches of mercury (-75 kPa)

Remove apparatus from service until repairs can be made.
After completing the previous tests, prepare the pumper for the remainder of the tests.

1. Open discharge valve
2. Remove cap from end of intake hose and attach strainer
3. Prepare intake hose for drafting
4. Connect discharge pressure test gauge to pressure side of test fitting on pump panel
5. Connect proper number of hoselines and nozzles
6. Attach pitot gauge
CAUTION

Before beginning the test, secure all nozzles to prevent injury to the personnel. Never attempt to hold a nozzle during the test procedure.
After preparing the apparatus, operate the priming system until the pump achieves prime and is discharging water.

**NFPA® 1911 fire pump requirements**

- 1,250 gpm (5 000 L/min) capacity pumps must achieve prime in 30 seconds or less
- 1,500 gpm (6 000 L/min) capacity pumps must be primed within 45 seconds
- Additional specifications offer increased time based on size of intake piping
The pumping test evaluates the overall operation of the engine and fire pump.

### Adjustments

- To achieve correct engine and nozzle pressures for pump capacity, testing of series of adjustments is required
- Pressure changes should be made slowly
- Allow time for pressure changes to register on test gauges

### Considerations

- A fixed pitot with a remote gauge capable of being read at the pump is recommended
- Ensure apparatus engine temperature and oil pressure remain within normal operating ranges
- Document and report any unusual vibration or performance defect
Pressure control devices must be tested to ensure they operate as designed.

**Pressure control devices**

Maintain safe level of pressure on pump when valves are closed at a range of discharge pressures

**Pressure control test**

Performed in three-part sequence

May be completed while pump is still set up from pumping test
The discharge pressure gauge must be tested to ensure accurate information is available for the driver/operator.

Improperly calibrated gauges may cause driver/operator to unintentionally supply dangerously low or high pressures to firefighters operating attack lines.
When discharges are equipped with a flowmeter, a different procedure must be used.

Connect a hoseline with solid stream nozzle to each discharge to be tested.

Determine actual flow rate using pitot gauge at the discharge of the solid stream nozzle.

| Difference in readings between flowmeter and pitot gauge must not be more than ten percent | Any reading beyond ten percent requires repair or replacement of flowmeter |
The tank-to-pump flow test must be conducted on any apparatus equipped with an onboard water tank.

Verifies piping between onboard tank and pump is sufficient to supply minimum amount of water

<table>
<thead>
<tr>
<th>Capacity</th>
<th>Flow Rate</th>
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<tbody>
<tr>
<td>500 gallons (2000 L) or less</td>
<td>250 gpm (1000 L/min)</td>
</tr>
<tr>
<td>500 gallons (2000 L) or more</td>
<td>At least 500 gpm (2000 L/min)</td>
</tr>
</tbody>
</table>
The operation of the internal intake pressure relief valve and all appliance intake relief valves should be tested.

1. Discharge hoseline from second pumper is connected to intake of apparatus being tested.
2. Discharge pressure from supply pumper increased until internal intake relief valve on test pumper opens.
3. Record pressure at which internal intake relief valve actuated.
4. Compare recorded pressure to test results and operating procedures used by jurisdiction where pumper is in service.
During testing, pumpers must not show signs of overheating, power loss, or other mechanical issues.

Upon test completion, check fluid levels and note losses.

Record test results per policy of jurisdiction.

Any apparatus that achieves results less than 90 percent of its originally rated capabilities:
- Place out of service, return to original capabilities, test again.
- Give a lower rating based on results of most recent test.
One or more of the following issues may be to blame if a pump fails to meet the requirements of the service test.

<table>
<thead>
<tr>
<th>Transmission in wrong gear</th>
<th>Lockup clutch with automatic transmission apparatus not functioning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clutch slipping</td>
<td>Engine overheating</td>
</tr>
<tr>
<td>Muffler clogged</td>
<td>Tachometer inaccurate</td>
</tr>
<tr>
<td>Engine governor malfunctioning</td>
<td>Insufficient intake hose</td>
</tr>
<tr>
<td>Intake strainer submerged incorrectly or intake screen clogged</td>
<td>Lift higher than 10 feet (3 m)</td>
</tr>
</tbody>
</table>
One or more of the following issues may be to blame if a pump fails to meet the requirements of the service test.

<table>
<thead>
<tr>
<th>Intake hose clogged or lining collapsed</th>
<th>Excessive air leaks on intake side of pump as result of bad pump seals</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pump impellers clogged</td>
<td>Clearance rings that are excessively worn</td>
</tr>
<tr>
<td>Pump or intake hose not fully primed</td>
<td>Malfunctioning relieve valve or pressure governor</td>
</tr>
<tr>
<td>Transfer valve in wrong position</td>
<td>Malfunction of gauges</td>
</tr>
<tr>
<td>Pitot gauge malfunctioning or clogged</td>
<td>Nozzle too large or too small</td>
</tr>
</tbody>
</table>
What tests are included when conducting performance testing?

What are some site considerations when performing pumper performance tests?
What equipment is required for performance tests on fire department pumpers?
Describe methods for testing a foam proportioning system.
Foam proportioning equipment must be tested before being placed in service, and periodically thereafter.

Generally checked by one of two methods:

- Testing foam to water concentration that system and equipment are able to produce.
- Testing rate at which foam concentrate is consumed in proportion to known flow of water through the system.
There are four basic methods of testing a foam proportioning system for calibration accuracy.

1. Foam concentrate displacement method
2. Foam concentrate pump discharge volume method
3. Foam solution refractivity testing
4. Foam solution conductivity testing
The foam concentrate displacement method checks the volume of foam concentrate drawn through the system.

- Foam system operated at predetermined flow using water instead of foam concentrate
- Water drawn from calibrated tank instead of foam concentrate tank or five gallon (20 L) pails
- Volume of water drawn from tank measured over time is correlated to actual percentage of foam concentrate the system would have drawn
NOTE

Because water has a different viscosity than foam concentrate, it will be drawn into the proportioning system at a slightly different rate. The manufacturer of the proportioning system or the foam concentrate should be able to supply a correction factor that can be applied to ensure testing accuracy when water replaces foam.
Certain direct injection type proportioning systems may use the foam concentrate pump discharge volume method.

Water may be used as substitute for foam concentrate

Foam system operated at predetermined flow while discharge from foam concentrate pump is collected in a calibrated tank for specified period of time

Volume in calibrated tank then correlated to actual percentage of foam concentrate the system should proportion
The foam solution refractivity test is used to ensure the quality of protein and fluoroprotein based foam solutions.

Amount of foam concentrate present in solution measured by refractometer

To develop base calibration curve for test analysis, proportion rate of foam concentrate must be determined by making base curve solutions.
The foam solution conductivity test is used to ensure the quality of synthetic based foam.

Direct reading conductivity testing

Conductivity comparison testing

Conductivity calibration curve testing
What methods are used for testing a foam proportioning system for calibration accuracy?