Diesel Fuel Systems

Injection Nozzles
Unit Terms

• Injection nozzle
  – Nozzle, nozzle holder, valve, spring assembly

• Nozzle assembly
  – Valve, body, and spray valve

• Orifice
  – Small hole

• Pintle
  – Valve which the end extends into the shank or pin
Functions of Injection Nozzles

• Atomizes the fuel for better combustion
• Spreads the fuel spray to fully mix with air
Moving Parts of the Nozzle

- Valve
- Spring
- Spindle
- Retainer
Common Types of Nozzles

• Single hole, capsule
  – Used in engines with pre-combustion chambers

• Multiple orifice
  – Has several small holes
  – Has a tendency to plug

• Single hole, pintle
  – Produces a hollow spray pattern
  – Can be either inward or outward opening
Injection Nozzle Adjustment

- Shim adjustment
- Screw adjustment
- Needle lift
- Pressure ranges
Injection Nozzle Action

- **Hydraulic action**
  - Diesel fuel hydraulically lifts the needle valve
- **Opening**
  - Pressure varies by injection nozzle design and application
- **Nozzle chatter**
  - An indicator of a properly working nozzle
Factors to Consider for Proper Nozzle Operation

• Maintain cleanliness
• Follow manufacturers specification exactly
  – Adjusting opening pressure 150 psi over spec will
    • Delay the start of injection
    • Increase fuel spray velocity
    • Lengthen spray cone
    • Decrease spray cone angle
    • Fuel droplet size to decrease
    • Cause fuel to settle out of the air stream
Locating Faulty Injectors

• Safety
  – Fuel leaking under pressure can penetrate skin
  – Watch for moving parts
  – Watch for hot parts
Locating Faulty Injectors

• When to perform test
  – Rough running engine
  – Engine misses
  – Major overhaul
Locating Faulty Injectors

• How to perform test
  – Operate engine at optimum rpm to detect miss
  – Crack each injection nozzle connector open one at a time using two wrenches, one hand method
  – Listen for a change in engine to indicate location of problem
Removing an Injection Nozzle

- Thoroughly clean area around injection nozzle.
- Identify type of retainer used to secure injection nozzle into the cylinder head.
Removing an Injection Nozzle

- Remove and cap high pressure fuel line.
- Remove and cap return line.
- Remove injection nozzle clamp.
- Pry injection nozzle out using two pry bars or by using a slide hammer puller.
Testing Injection Nozzles

• Superficial checks
  – Spray tip condition
  – Nozzle body condition
  – Threaded connection condition
Testing Injection Nozzles

• Cracking pressure
  – Bleed air from tester
  – Operate tester to purge air and seat valve
  – Open gauge valve, pump slowly to raise pressure
  – Read gauge when nozzle valve opens and closes
Testing Injection Nozzles

• Valve seat pressure
  – Relieve all pressure from tester
  – Dry spray tip
  – Bring pressure up to 200 psi below cracking pressure and hold for 10 to 15 seconds
  – Relieve pressure, recheck for fuel accumulation on spray tip
Testing Injection Nozzles

• Back leakage test
  – Checks fit of needle valve and nozzle bore
  – Bring pressure to within 100 psi of cracking pressure
  – Time the rate of pressure drop
  – Average pressure drop of not more than is 880 psi in 6 seconds shows good nozzle valve lubrication
Testing Injection Nozzles

• Spray pattern test
  – Close gauge valve to prevent damage to gauge
  – Operate pump at a rate of two strokes per second to simulate injection pump operation
  – Observe spray pattern
    • No spray distortion
    • No unatomized fuel
    • Uniform spray cone length and width
    • Audible nozzle chatter
Injection Nozzle Disassembly

• Work in a clean environment.
  – Care in working clean and using clean tools cannot be encouraged enough. Quality work starts here.

• Required tools.
  – Trays to hold each injection nozzle.
  – Wash containers.
  – Holding fixture to disassemble nozzles.
  – Cleaning tools.
  – Injection nozzle tester.
Disassembly Procedures

• Disassembly procedures.
  – Clean external surfaces of dirt and oil.
  – Using the holding fixture, remove spring retaining nut, spring, spring retainer and spindle.
  – Using holding fixture, remove the nozzle nut.
  – Place all parts in a tray containing diesel fuel or calibrating fluid to help prevent contamination.
Disassembly Procedures

• Parts cleaning.
  – Clean parts using a brass brush to prevent damage to polished surfaces.
  – Nozzle holder can be cleaned in solvent tank, however, nozzle valve assembly should be cleaned by hand to prevent damage.
  – Inspect needle valve for signs of burning, if burned or discoloration is evident, valve assembly should be replaced.
Checking Nozzle Parts

- Fuel sac
  - Clean fuel sac with a brass scraper
Checking Nozzle Parts

• Spray orifices
  – Select proper cleaning wire size
  – Use wire shaping stone to remove any burrs from wire
  – May need to shape a flat spot on wire to help remove carbon

• Sealing surfaces
  – Inspect sealing surfaces for indications of internal leakage
  – Lap on a lapping plate lubricated with mutton tallow
  – Clean with clean diesel fuel and air
Needle Lift

- Proper needle lift insures
  - Length of lift off time
  - Flow of fuel into combustion chamber
  - Spray cone width will be varied
  - Length of spray cone will be affected
  - Checked with a dial indicator
    - Typically ranges from 0.012-0.027
  - Lap nozzle valve body to change if lift is too great