## Mack Part #509GC471 Batch "U" Liner Manufacturing Federal Mogul Visit 4/10/2013

## Batch "U" Liner Manufacturing

- Visited Federal Mogul Liner production plant in Lake City, MN on 4/10/2013
  - Reviewed Specifications
  - Observed operations
    - Casting (other liners)
    - Cutting
    - Grinding
    - Finish Honing
  - Set up Initial expedite orders

# Batch "U" Liner Manufacturing

- Liner Specifications
  - Crosshatch Angle =  $45^{\circ} \pm 2.5^{\circ}$
  - Rvk = 40 µin ± 5 µin
  - Target Values of other parameters
    - Ra = 14.9 µin
    - Rk = 37.9 µin
    - Rpk = 10.6 µin
    - Rmr1 = 6.1 %
    - Rmr2 = 82.5 %
    - Vo = 3302250 (µin\*µin)/in

## Batch "U" Liner Manufacturing Process Review

- Cast Liners
  - Class 40 Cast Gray Iron
  - Material verified at the beginning of each casting run
    - One liner is sectioned for microstructure analysis and sent to the spectrometer for composite analysis
  - About 0.090" oversize to allow for machining
- Liners are parted from the mold
  - Done by a tumbler system to separate parts and sand
- Sent to plant in Minneapolis to be through hardened
  - Hardening verified with 1 piece per treated lot

## Batch "U" Liner Manufacturing Process Review (continued)

- Machining Line
  - Rough bore cut and dimensions verified
    - About 0.008" under to allow for finish honing
  - Upper Flange/Pilot surface cut and deburred
  - Outer diameter ground and dimensions verified
  - Inner bore honed
    - 6 4" length stones x 0.300" width 320 grit vitreous stone, H bond
    - Stones changed every 20 liners First liner on new stones discarded
  - Crosshatch angle, dimensions and surface finish verified
    - Every piece measured in 9 places at floor level for surface finish
    - Every piece is measured for dimensions at floor level
    - 1 piece per shift is measured by the metrology lab for all print parameters (surface finish, angle's, runouts, concentricity's, etc.)
  - Liners cleaned, oiled and packaged

#### Batch "U" Liner Manufacturing Casting Cope 6 liners cast at one time



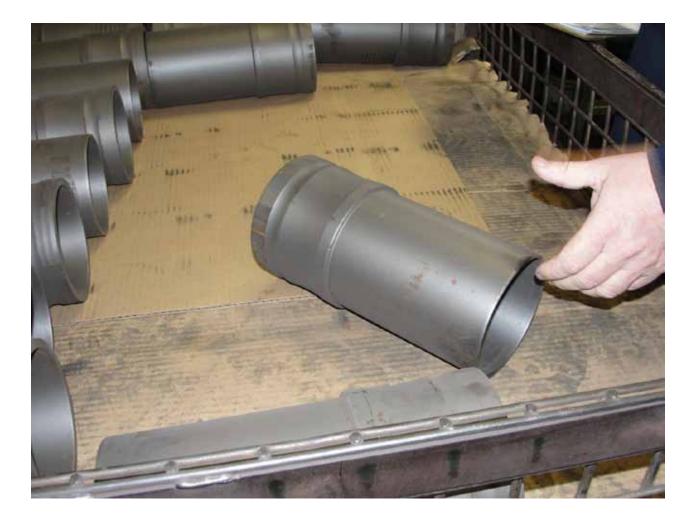
#### Batch "U" Liner Manufacturing Casting Flask Ready for Pour



#### Batch "U" Liner Manufacturing Castings in the Cooling Line



#### Batch "U" Liner Manufacturing Casting After Separation



#### Batch "U" Liner Manufacturing Castings Ready for Machining



#### Batch "U" Liner Manufacturing Liner Work Line



#### Batch "U" Liner Manufacturing Initial Boring Station



## Batch "U" Liner Manufacturing Flange Cutting and Deburring Station



#### Batch "U" Liner Manufacturing Liner Outer Surface Grinding



### Batch "U" Liner Manufacturing Liner Outside Measurement Device with Standard



#### Batch "U" Liner Manufacturing Honing Device



#### Batch "U" Liner Manufacturing Honing Fixture Clamp



## Batch "U" Liner Manufacturing Liner being Honed



#### Batch "U" Liner Manufacturing Liner Dimensional Measurement



#### Batch "U" Liner Manufacturing Liner Surface Finish Analysis



## Batch "U" Liner Manufacturing Liner Cleaning and Rust Prevention Coating



### Batch "U" Liner Manufacturing Surface Finish Device in Metrology Lab



#### Batch "U" Liner Manufacturing Pleasures of Winter Travel



#### Batch "U" Liner Manufacturing

• Questions?