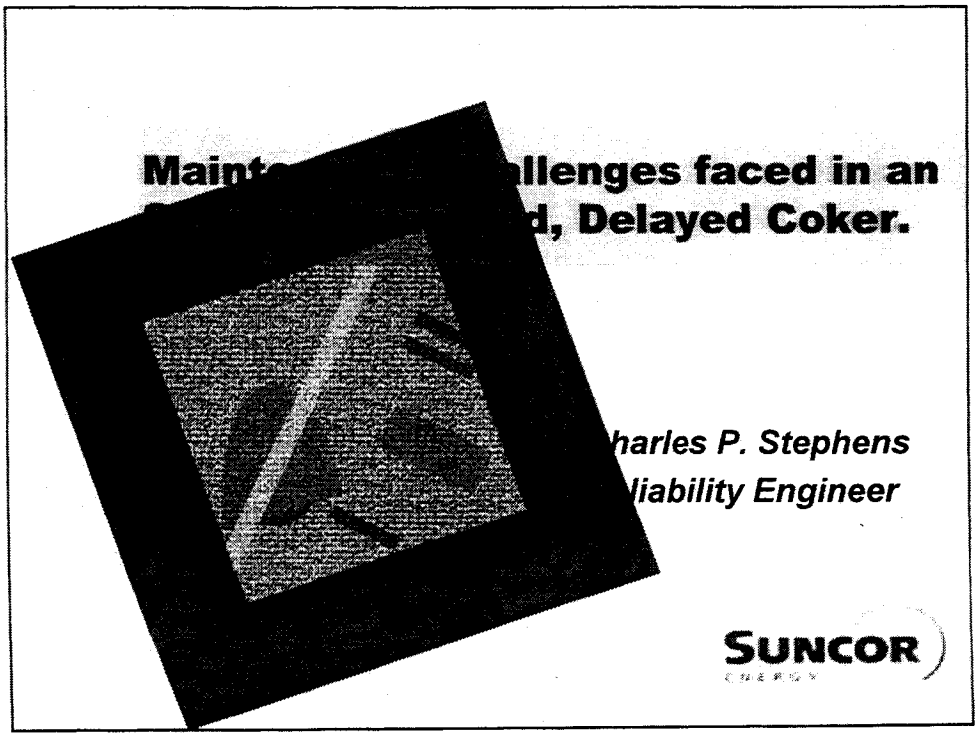
Maint llenges faced in an
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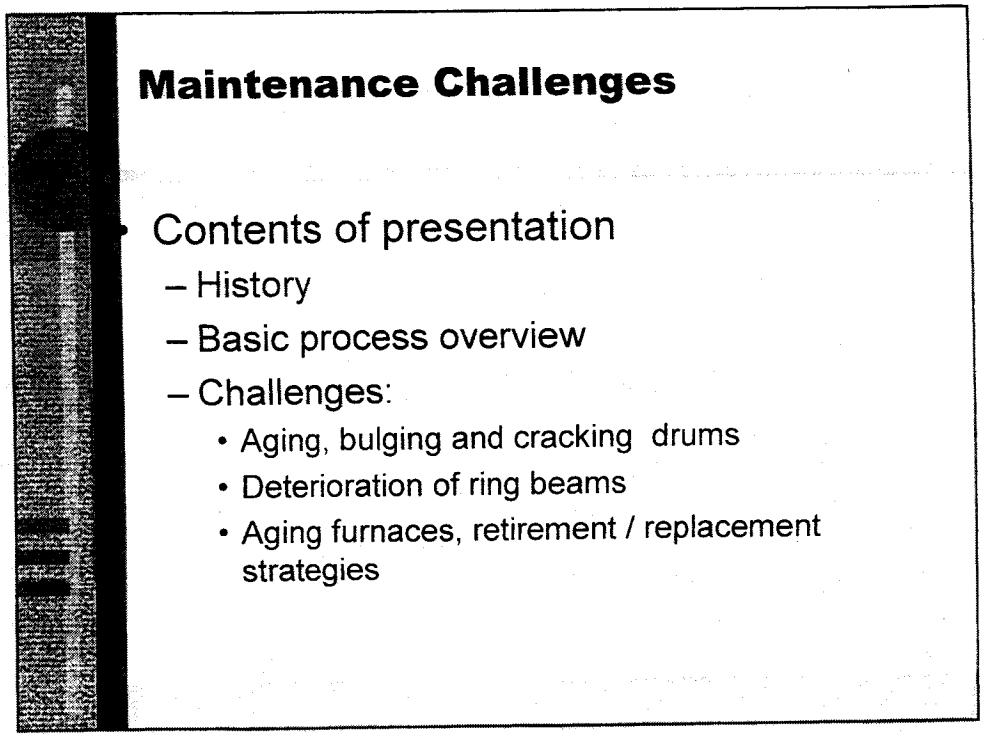
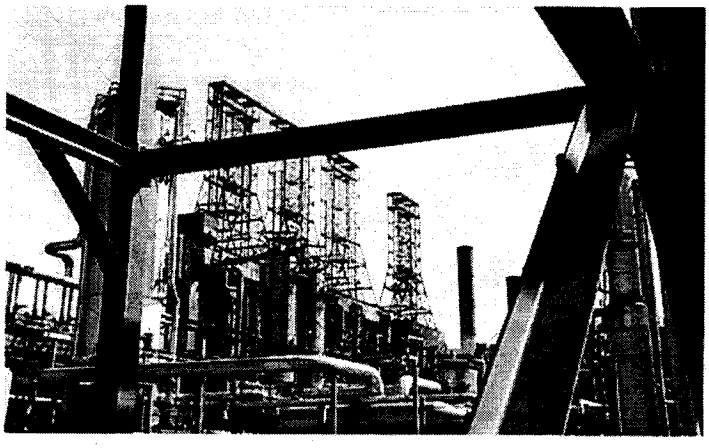
harles P. Stephens
liability Engineer
SUNCOR


Maintenance Challenges
Contents of presentation
– History
– Basic process overview
– Challenges:
• Aging, bulging and cracking drums
• Deterioration of ring beams
• Aging furnaces, retirement / replacement strategies

Maintenance Challenges

- Challenges: (continued)
  - de-heading
  - Coke condensate drum retirement
  - Coke cutting system
  - Future / ongoing developments
- Achievements:
  - 75% to 92 % Mechanical Availability
  - 45 Kbbls/day to 125 Kbbls/day

Maintenance Challenges



Maintenance Challenges

- History
  - Constructed in1967 as a 3 set i.e. six drum unit
  - Primary unit in Upgrading not a back end unit
  - Initial processing capacity of 3000 bbl/hr.on 24 hour cycles
  - A fourth set added in 1980

Maintenance Challenges

- 1997 went to 8 drum operation on 18 hour cycles
- Installed a vacuum unit in 1998 to further process diluted bitumen, recovery of diluent and HVGO, LVGO blend components
- Installed second steam out system to handle extra vapor traffic in 2000
- Moving towards 12 hour cycles

Maintenance Challenges

- Basic process overview
  - Tar sand is mined, bitumen is extracted and Naphtha added in the Extraction facility to allow transportation
  - Diluted Bitumen from Extraction facility feeds a Diluent Recovery Unit and a Vacuum unit

Maintenance Challenges

- Diluent is recovered and shipped back to Extraction facility
- Recovered bitumen & vacuum bottoms as coker charge, LVGO & HVGO used as blend components
- Coker furnaces crack bitumen (4 x 1260 bbls/hr @ 940° F)
- Sponge coke used as fuel for our power boilers

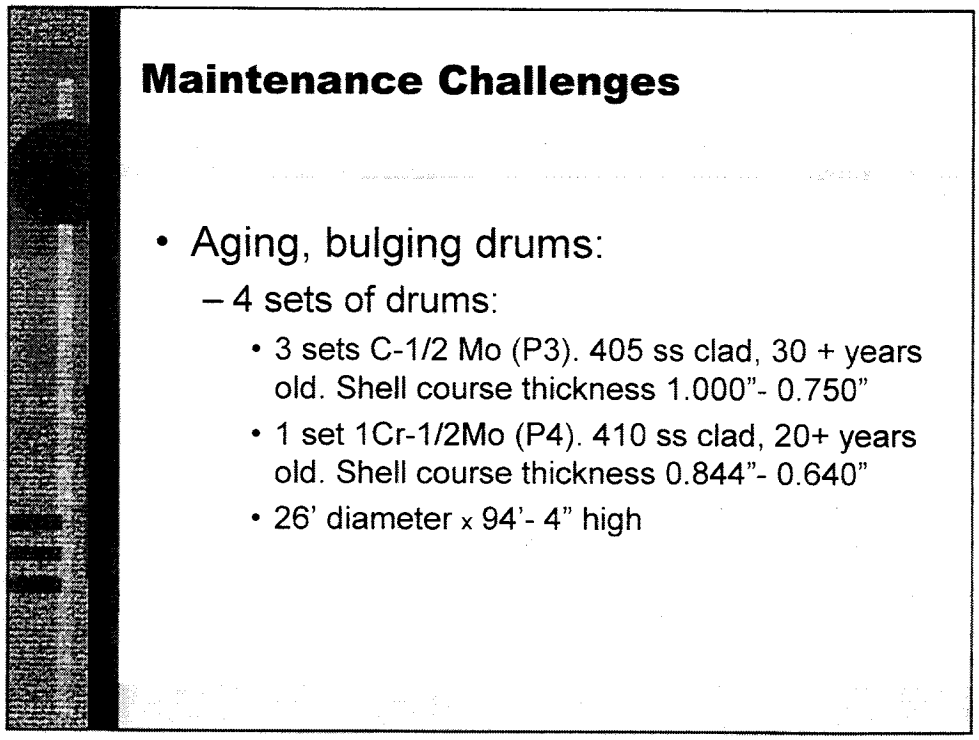
Maintenance Challenges

- Overheads from coke drum sent to fractionater
- Fractionater products to respective hydro-processing (Unifiners)
  - Heavy Naphtha
  - Kero
  - Gasoil
  - Frac. Overheads to gas recovery unit
    - Distillate Naphtha and butane to Naphtha-Unifiner

Maintenance Challenges

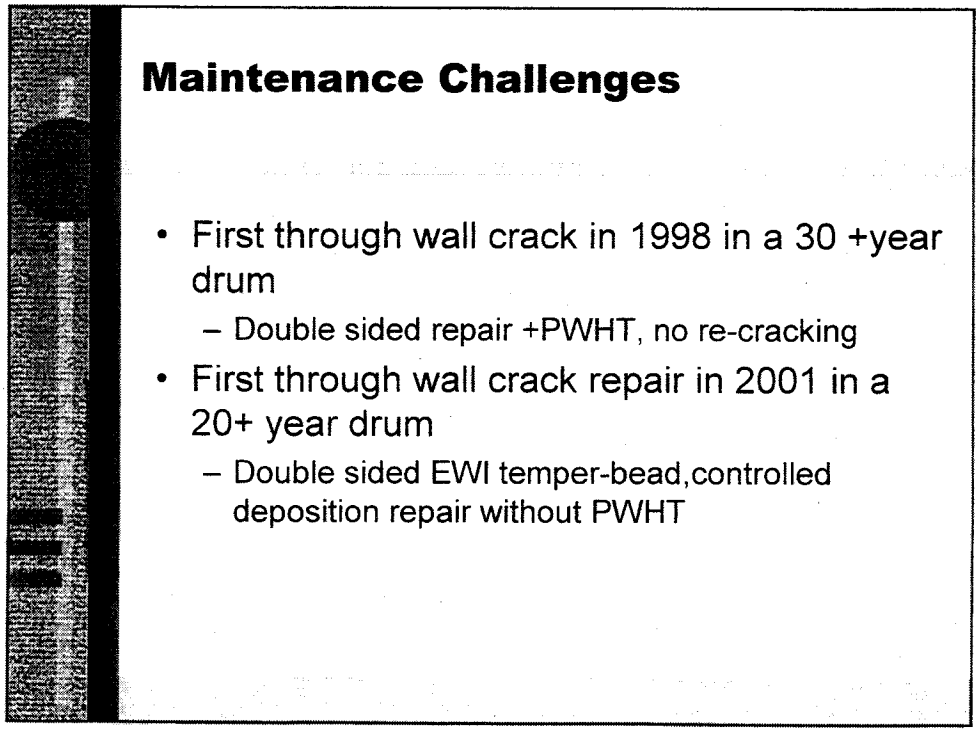
Challenges

- 12-14 hour cycles
  - All familiar with the sequence;
    - other drum switch complete, steam quench to frac
    - steam quench to steam out, water quench
    - Pull top head, drain drum, pull bottom head
    - Cut drum,head up top & bottom, steam test
    - Vapor heat, switch drum --- **ALL IN 12 HOURS**!



Maintenance Challenges

- Aging, bulging drums:
  - 4 sets of drums:
    - 3 sets C-1/2 Mo (P3). 405 ss clad, 30 + years old. Shell course thickness 1.000"- 0.750"
    - 1 set 1Cr-1/2Mo (P4). 410 ss clad, 20+ years old. Shell course thickness 0.844"- 0.640"
    - 26' diameter x 94'- 4" high



Maintenance Challenges

- First through wall crack in 1998 in a 30 +year drum
  - Double sided repair +PWHT, no re-cracking
- First through wall crack repair in 2001 in a 20+ year drum
  - Double sided EWI temper-bead,controlled deposition repair without PWHT

Maintenance Challenges

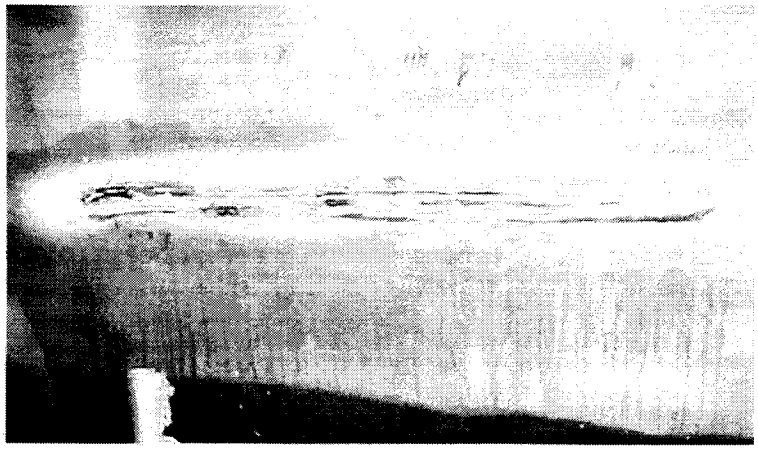
- Major base material build up in 2002 in a P3 30+ year drum
  - Cladding loss due to 885 Embrittlement and thermal fatigue
  - Significant base material loss due to "Sulfidic" corrosion (McConomy)

Maintenance Challenges

- Development of life extension strategies:
  - 2 % diametrical growth, 3" local bulge radius
  - Follow up on blunt thermal fatigue cracks "Elephant skin" appearance on cladding
  - LPI and Repair of corrosion fatigue on seams
  - External shear-wave UT at circ. seams
  - Criteria for patch plate repair based on multiple repairs (>2) on same bulge and seam
  - Drum set inspection frequency of two years
  - laser map-scan as a non intrusive inspection device
  - Single sided repair procedure

Maintenance Challenges

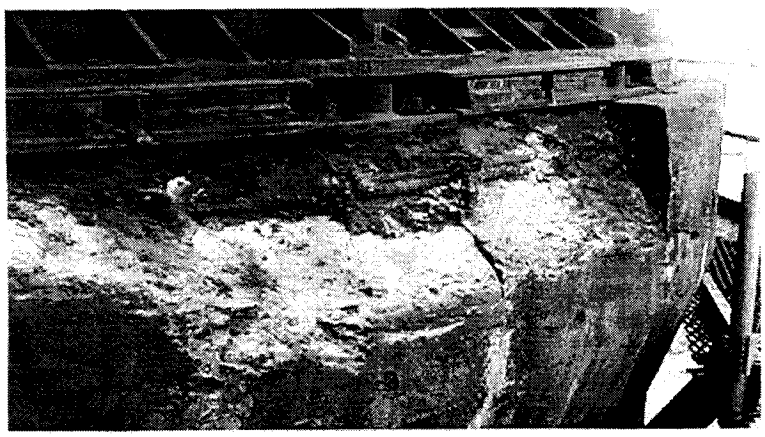
Maintenance Challenges



Maintenance Challenges

- Cracked Ring Beams
  - Spalling of concrete, exposing re-bar
  - Binding of slide plates
  - Bolt bound, bolt breaking
  - Previous repairs determined to be cosmetic,i.e. repairs not load bearing
  - Longitudinal cracks down length of support
  - Continuously "repairing the repair"
  - fitness for service and prioritize drums for Long term repair strategy

Maintenance Challenges



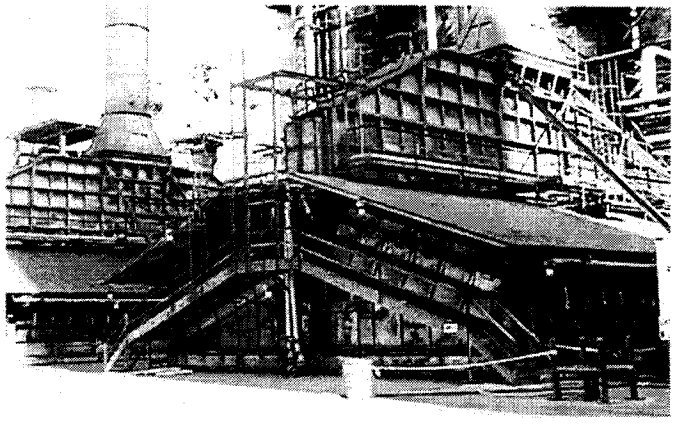
Maintenance Challenges

Aging coker furnace tubes, retirement / replacement strategies

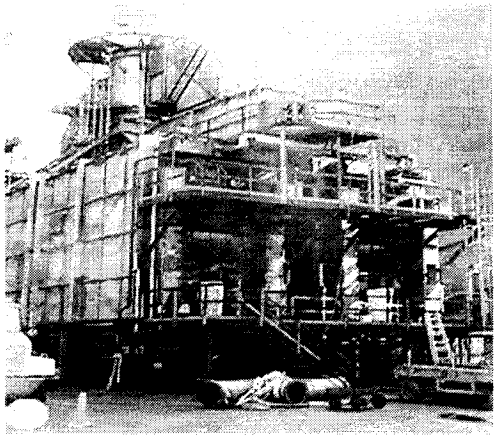
- 4 furnaces, 3 circa '67, 1 circa '80
  - 9Cr-1Mo, 4.5" OD tubes
- 4 pass, 35 year old, cabin style with dividing bridgewall, horizontally fired with 40 premix burners
- 4 pass, 22 year old, two cell box, bottom fired, with a common convection section

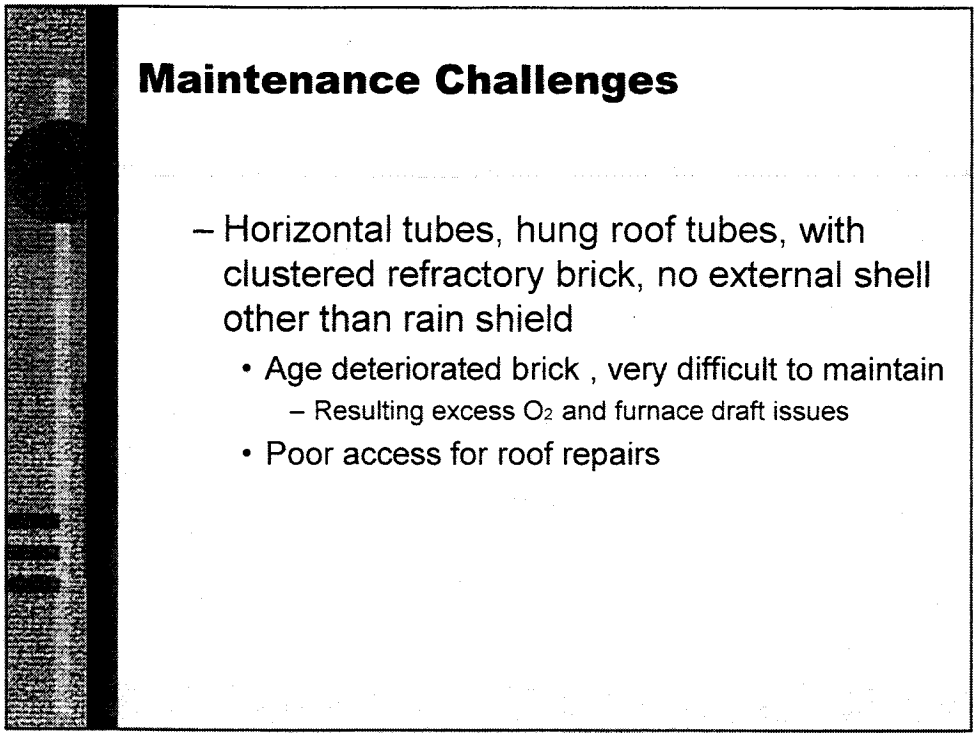
Maintenance Challenges

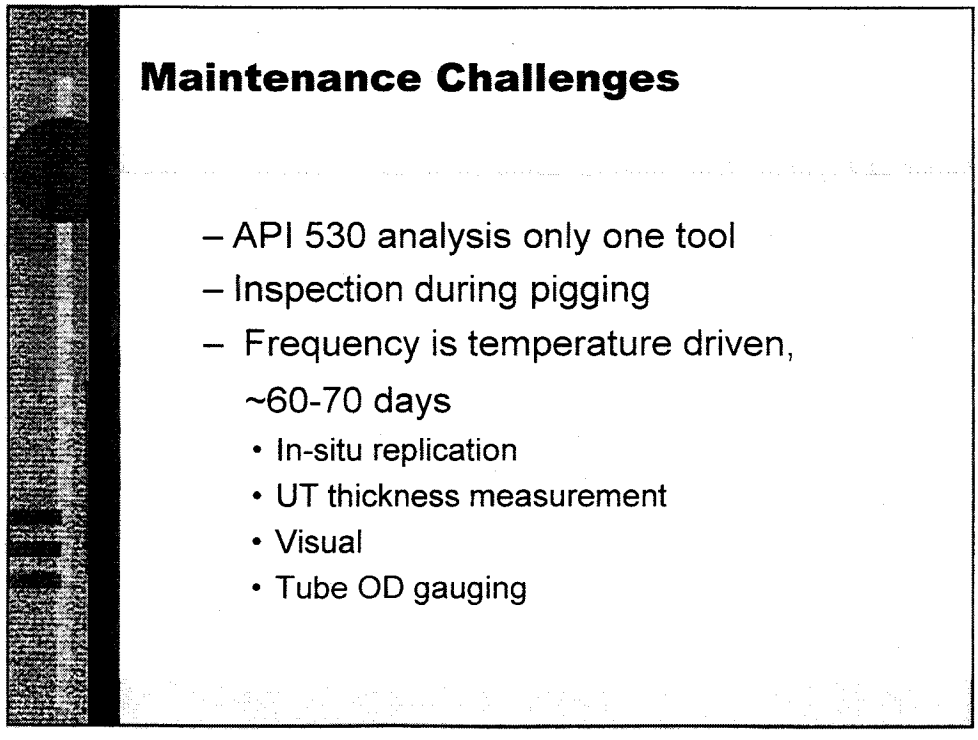
Maintenance Challenges

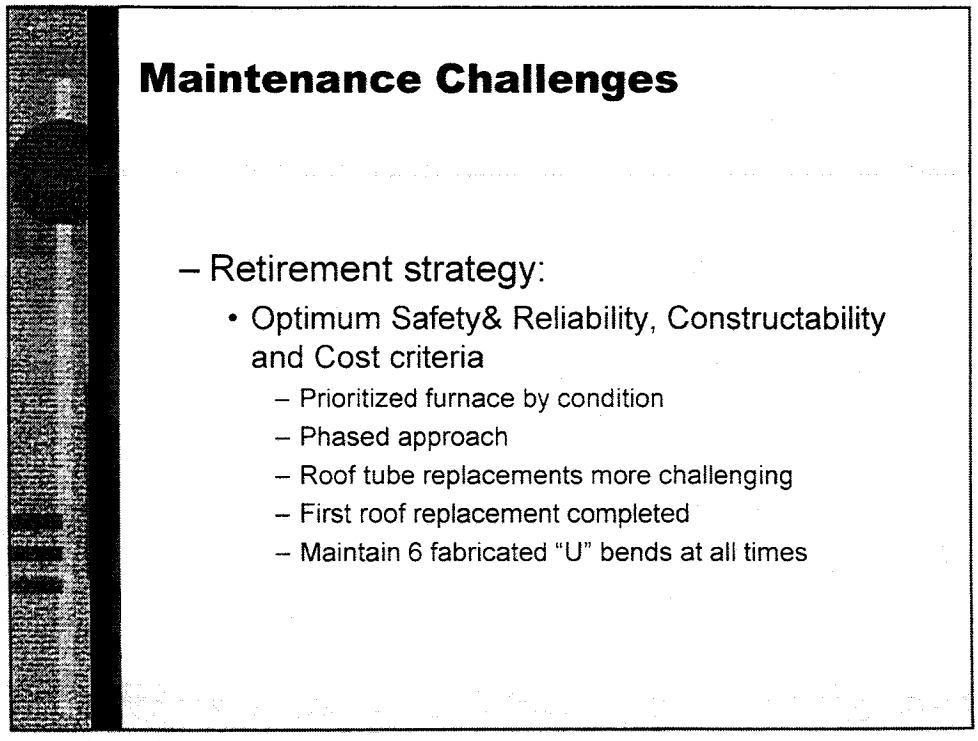


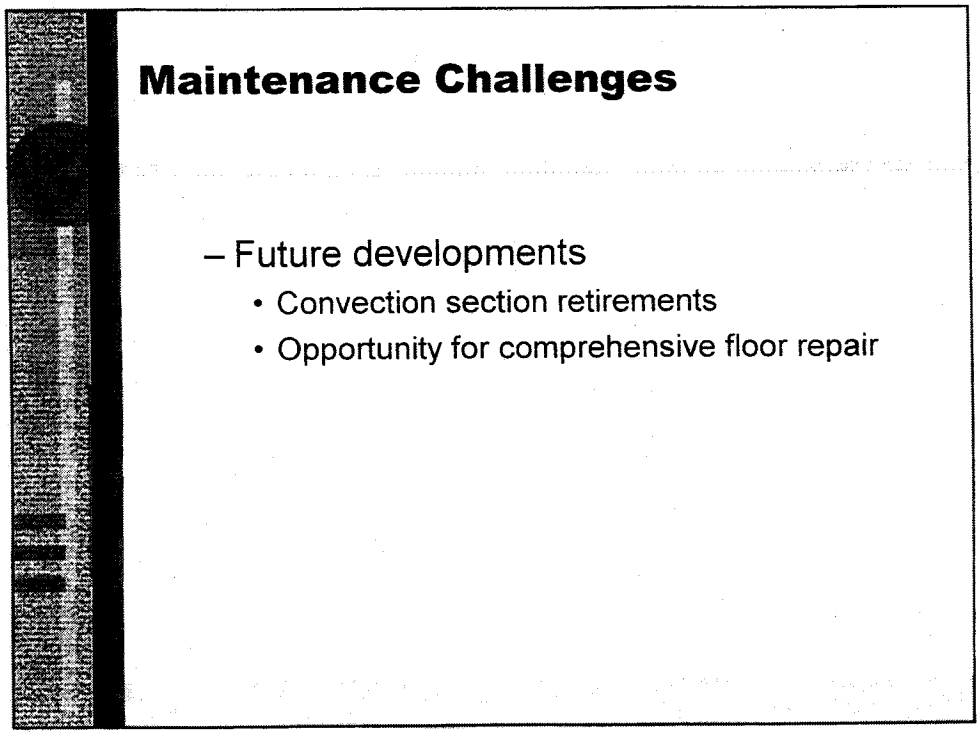
Maintenance Challenges




Maintenance Challenges
– Horizontal tubes, hung roof tubes, with clustered refractory brick, no external shell other than rain shield
• Age deteriorated brick , very difficult to maintain
– Resulting excess O_2 and furnace draft issues
• Poor access for roof repairs


Maintenance Challenges
– API 530 analysis only one tool
– Inspection during pigging
– Frequency is temperature driven, ~60-70 days
• In-situ replication
• UT thickness measurement
• Visual
• Tube OD gauging


Maintenance Challenges
– Retirement strategy:
• Optimum Safety& Reliability, Constructability and Cost criteria
– Prioritized furnace by condition
– Phased approach
– Roof tube replacements more challenging
– First roof replacement completed
– Maintain 6 fabricated "U" bends at all times


Maintenance Challenges
– Future developments
• Convection section retirements
• Opportunity for comprehensive floor repair

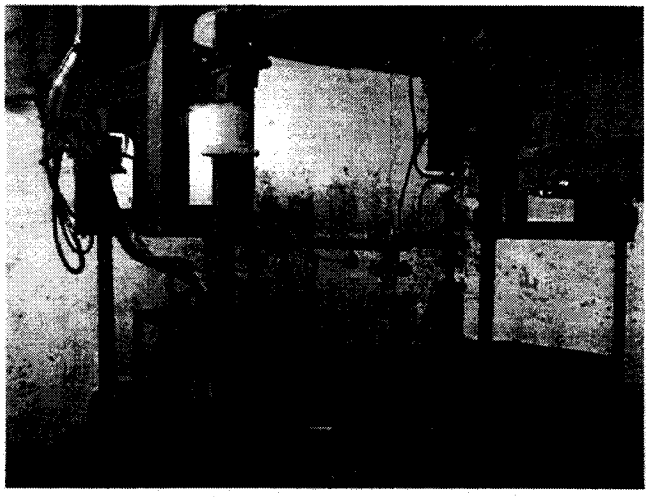
Maintenance Challenges

Coke drum de-heading

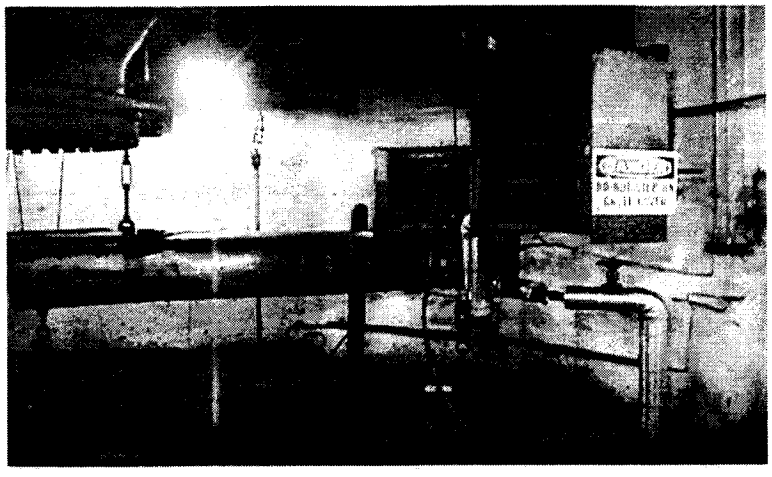
- In house hydraulic head removal/carriage
- De-coupled the pneumatic telescopic chute system from the carriage system
  - Reduced chute binding problems
- Slope chutes in need of major refurbishment.

Maintenance Challenges

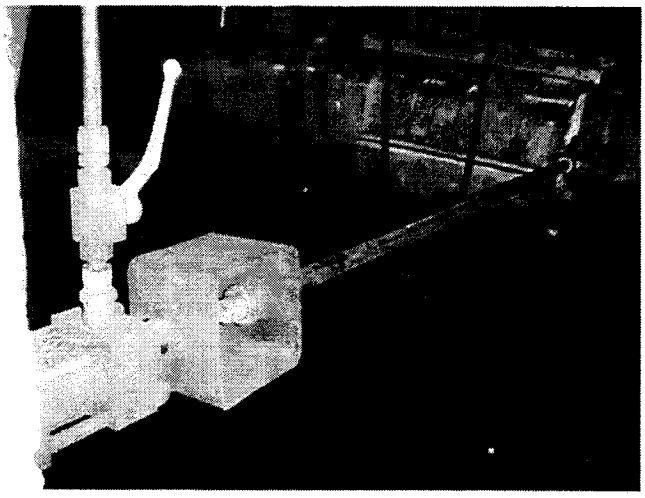
Maintenance Challenges



Maintenance Challenges



Maintenance Challenges



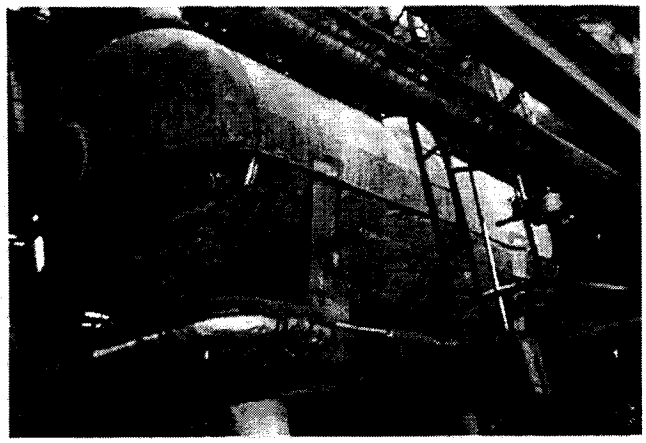
Maintenance Challenges

- Coke condensate drum fatigue cracking
  - Condensed hydrocarbon liquid is recovered from drum vapor heat and further stripped to yield feed to coker feed drum
  - Needed for hydraulic reasons.

Maintenance Challenges

- 4 condensate drums 3 circa 67', 1 circa '80
- All drums have experienced cracking
- One drum has had up to 12 separate repairs
- Attributed to thermal fatigue
- Remediation options:
  - Investigating replacement options including partial elimination

Maintenance Challenges

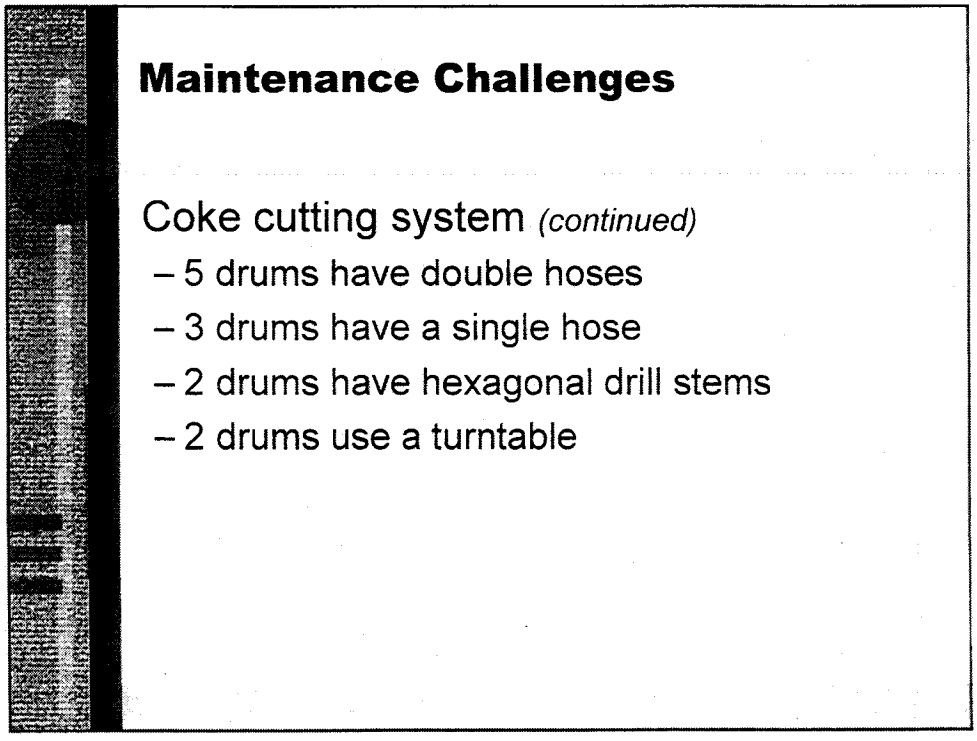


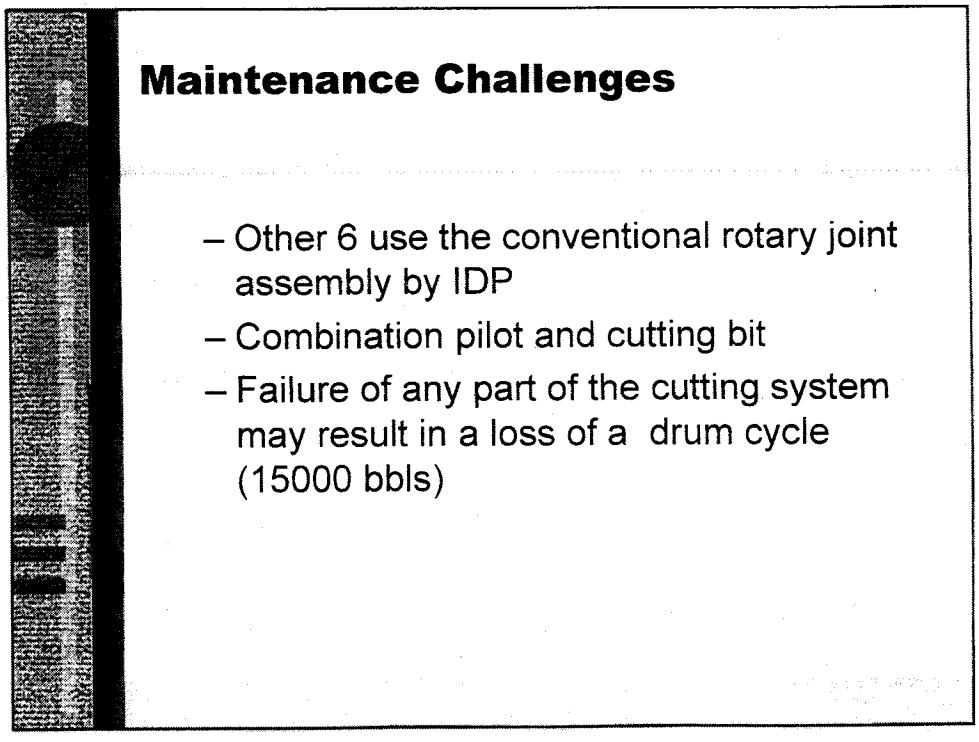
Maintenance Challenges

Coke cutting system

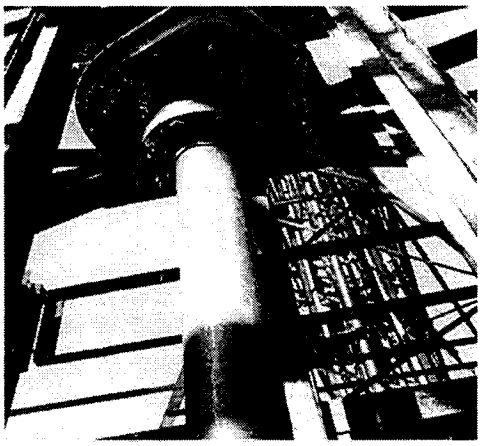
- Cutting pump 2 x 4" 9 stage Dresser pump 750usgpm@ 3000 psig
- Piping to accommodate dual cutting
- Use of "swing elbows" to switch between drums in a drum set
- Use of "alternate spools" to allow duel cutting

Maintenance Challenges

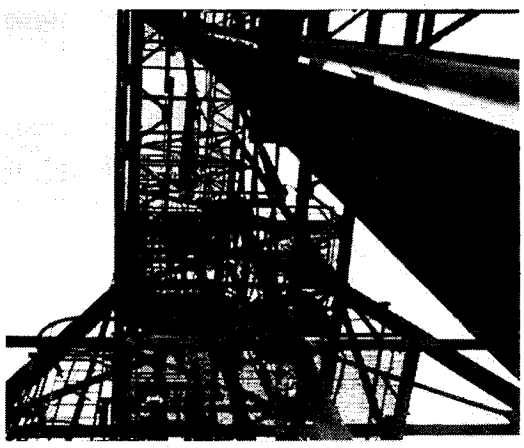

Maintenance Challenges
Coke cutting system (continued)
– 5 drums have double hoses
– 3 drums have a single hose
– 2 drums have hexagonal drill stems
– 2 drums use a turntable


Maintenance Challenges
– Other 6 use the conventional rotary joint assembly by IDP
– Combination pilot and cutting bit
– Failure of any part of the cutting system may result in a loss of a drum cycle (15000 bbls)

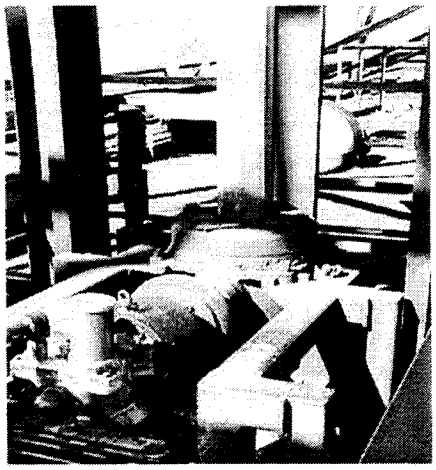
Maintenance Challenges



Maintenance Challenges



Maintenance Challenges



Maintenance Challenges

Coke cutting system *(continued)*

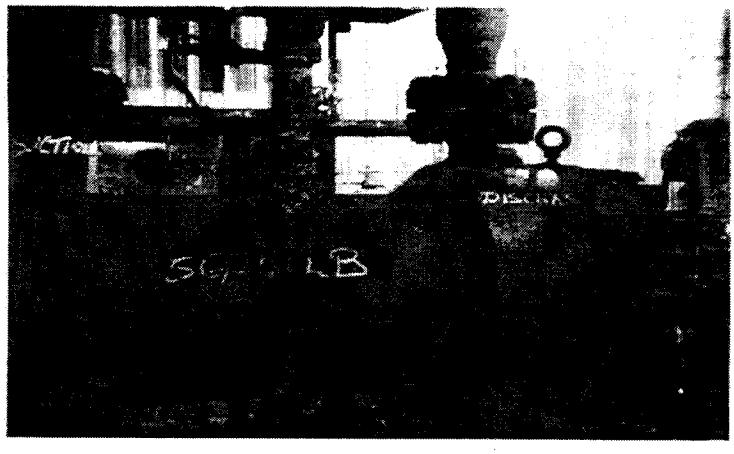
- Use of swivel joints to maintain flexibility of drill hose
  - Was a high maintenance item but upgraded seal material
  - "Swivel elimination" underway
- Rotary table failure requires drill stem to be cut

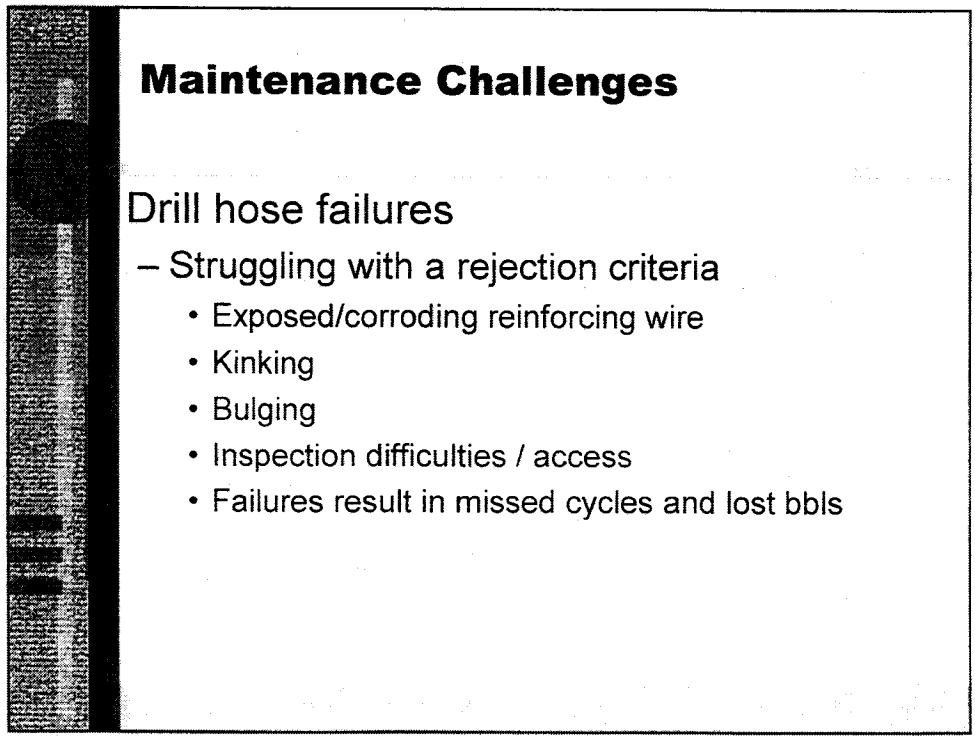
Maintenance Challenges

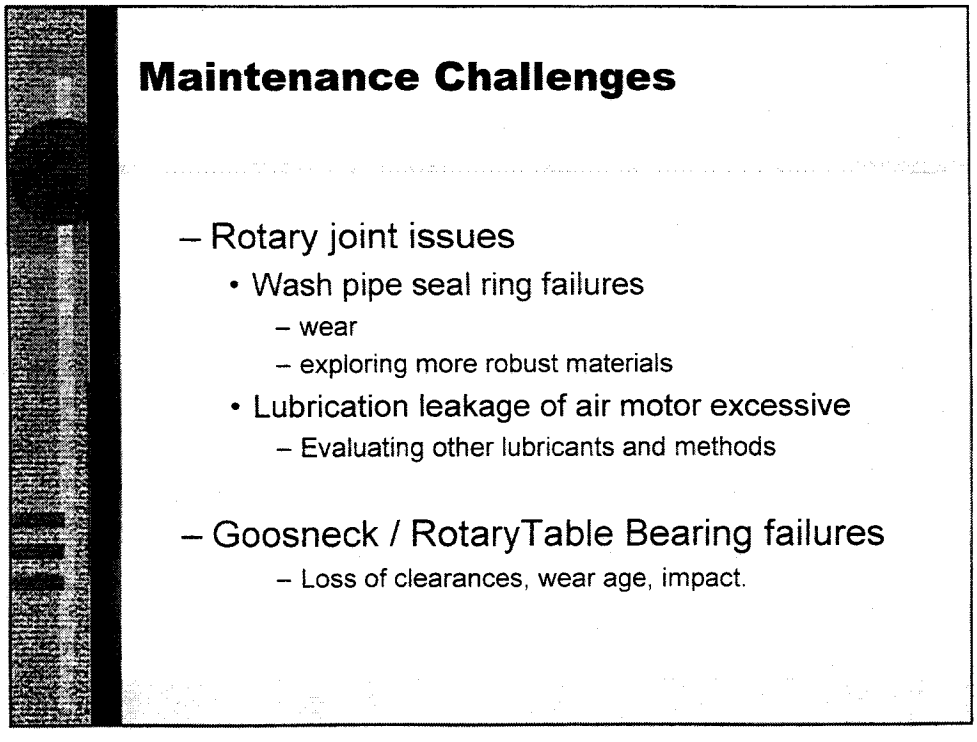
Coke cutting system *(continued)*
Redundant pump pressed into full time service to lower cycle time

- Shaft fatigue failures
  - Modified thrust collar
- Measure wear ring wear for rebuild frequency

Maintenance Challenges




Maintenance Challenges
Drill hose failures
– Struggling with a rejection criteria
• Exposed/corroding reinforcing wire
• Kinking
• Bulging
• Inspection difficulties / access
• Failures result in missed cycles and lost bbls


Maintenance Challenges
– Rotary joint issues
• Wash pipe seal ring failures
– wear
– exploring more robust materials
• Lubrication leakage of air motor excessive
– Evaluating other lubricants and methods
– Goosneck / RotaryTable Bearing failures
– Loss of clearances, wear age, impact.

Maintenance Challenges

- Future Developments
  - Long term retirement of W-S switch valves
  - Long term rehabilitation of coke drum foundations
  - 12 hour cycles
  - Third coker charge pump (availability)
  - RCM evaluations of charge system. Follow up on coke cutting RCM recommendations
  - Many, many more!

Maintenance Challenges

- Achievements:
- 75% M. A to 92 % M.A.
  - Executing critical maintenance and inspections during planned outages.
  - Taking advantage of pigging opportunities for key inspections and maintenance.
  - Executing the right repair on the right equipment at the right time.
  - Focus capital on reliability and availability improvement.