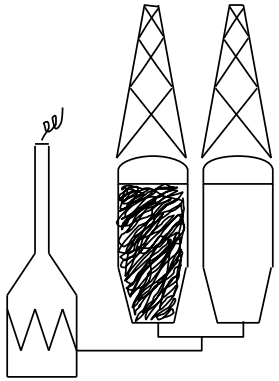
Delayed Coker
Coke Drum Top Head Safety



Presented by Mitch Moloney of **ExxonMobil Research & Engineering**

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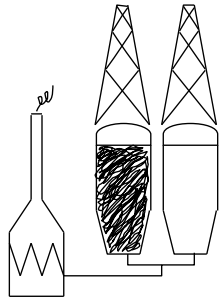
RIO DE JANEIRO
29 Sept – 3 Oct 2014

Coking.com

Top Head Safety



Purpose:

Discuss Methods of Improving Top Head Safety at ExxonMobil and in the Industry. The review focuses on Evolution of safety devices and procedures on delayed cokers

Topics:

Risk Breakdowns

=> vent, drain, top head / guideplate positioning, coke cutting

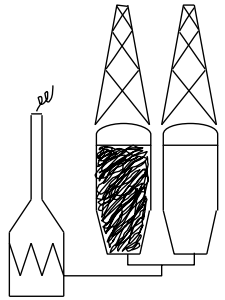
Evolution of Top Head Designs

=> ExxonMobil and Industry Perspectives

ExxonMobil Upgrades to Procedures & Facilities

=> Reduce Risk and Improve Reliability

Top Head Safety



Top Deheading – Fundamental Risk Scenarios

(1) Venting

=> Open vent on live drum

=> Exposure of technician to steam and/or hot condensate due to location of vent

(2) Draining

=> Open drain on live drum

=> Leave warm-up condensate valve(s) open prior to drain

=> Fail to open vent, slowing drain or damaging coke drum

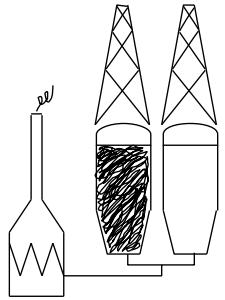
(3) Top Head Assemblies Removal / Replacement

=> Burn due to hot metal exposure during "hot-bolting" operations

=> Steam/condensate burns during unbolting

=> Boil-Over Risk

Top Head Safety



Top Deheading – Fundamental Risk Scenarios

(3) Top Head Equipment Removal / Replacement (cont'd)

=> Hand/Finger injuries

=> Ergonomic injuries associated with using the pneumatic wrench, and moving the top flange and drill stem guide assembly

(4) Outage Measurement

=> Hot steam / condensate exposure

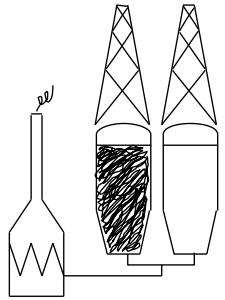
(5) Hot Steam/Condensate Exposure during Coke Cutting

=> Changing the Combination Tool Position

=> Stuck Drill Stem

(6) Slipping or Falling around the Top Head

Top Head Safety



Evolution of Facilities:

(1) Manually Bolted Top Head Flange Plate at the level of the cutting deck

Chain-Hoist and Trolley are used to move the flange plate

Drill stem guide assembly manually positioned with chain hoist

Old Top Head Operations

Unbolting the top head

Removing the top head

Top Head Safety

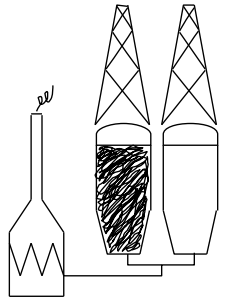
Evolution of Facilities:

(1) Manually Bolted Top Head Flange Plate (cont'd)

Drill Stem in Place

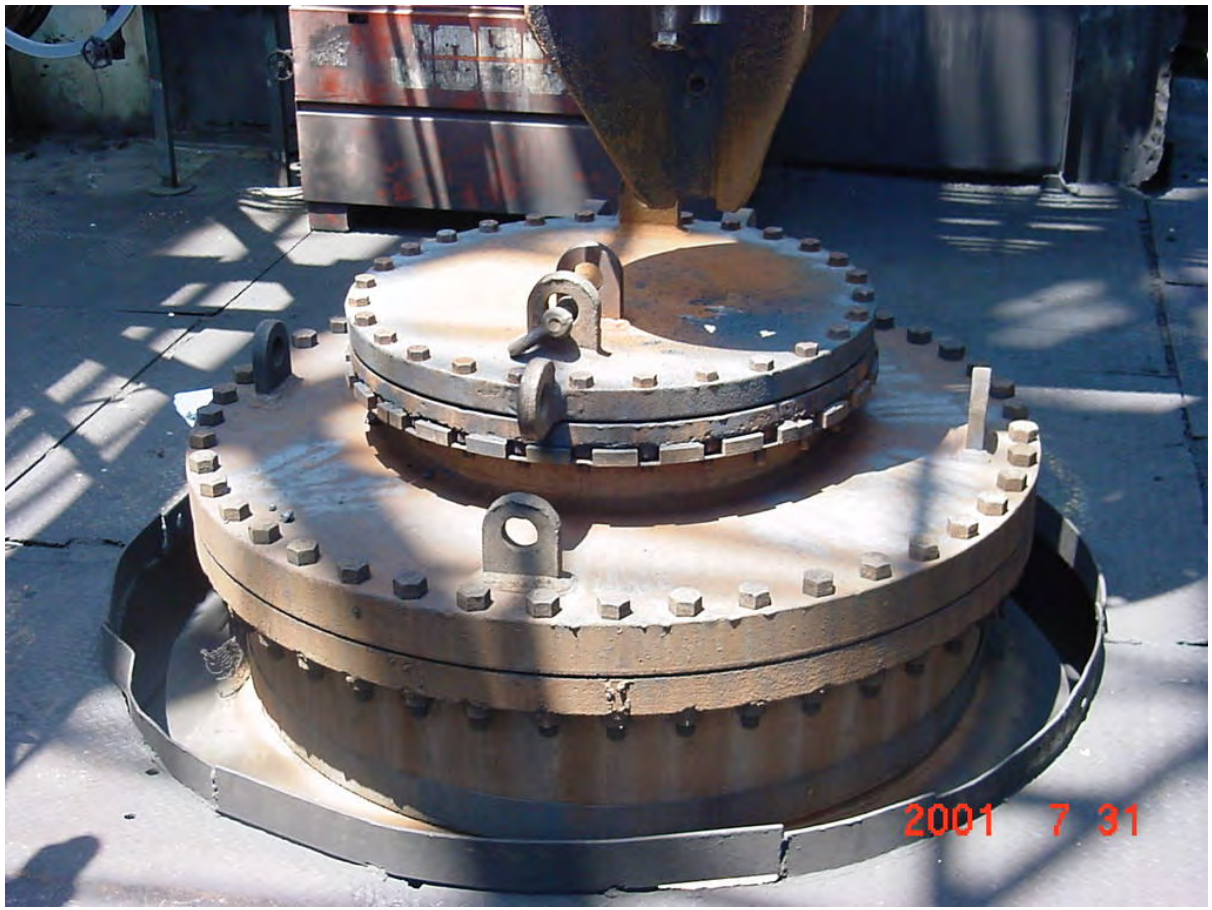
Measuring the Outage

Top Head Safety



Evolution of Facilities:

(2A) Reduced Top Head Diameter



Top Head Safety

Evolution of Facilities:

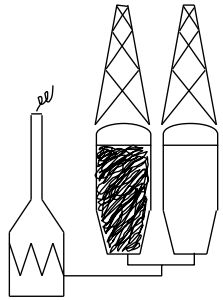
(2B) Floating Guide Plate on Drill Stem

Top Head Safety

Evolution of Facilities:

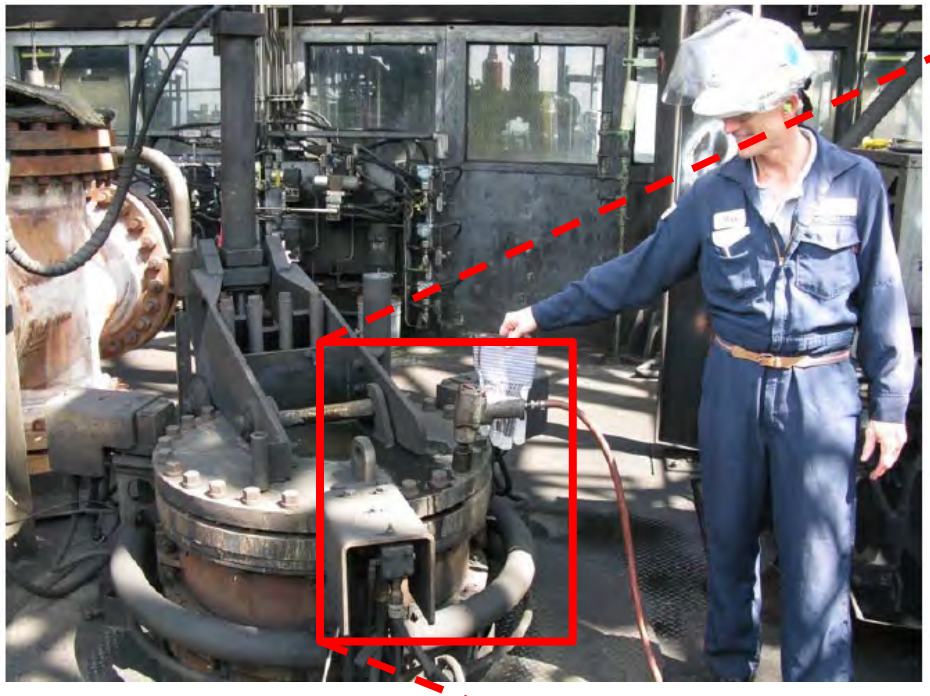
(2C) Guide Plate with Steam Vent Holes

Top Head Safety



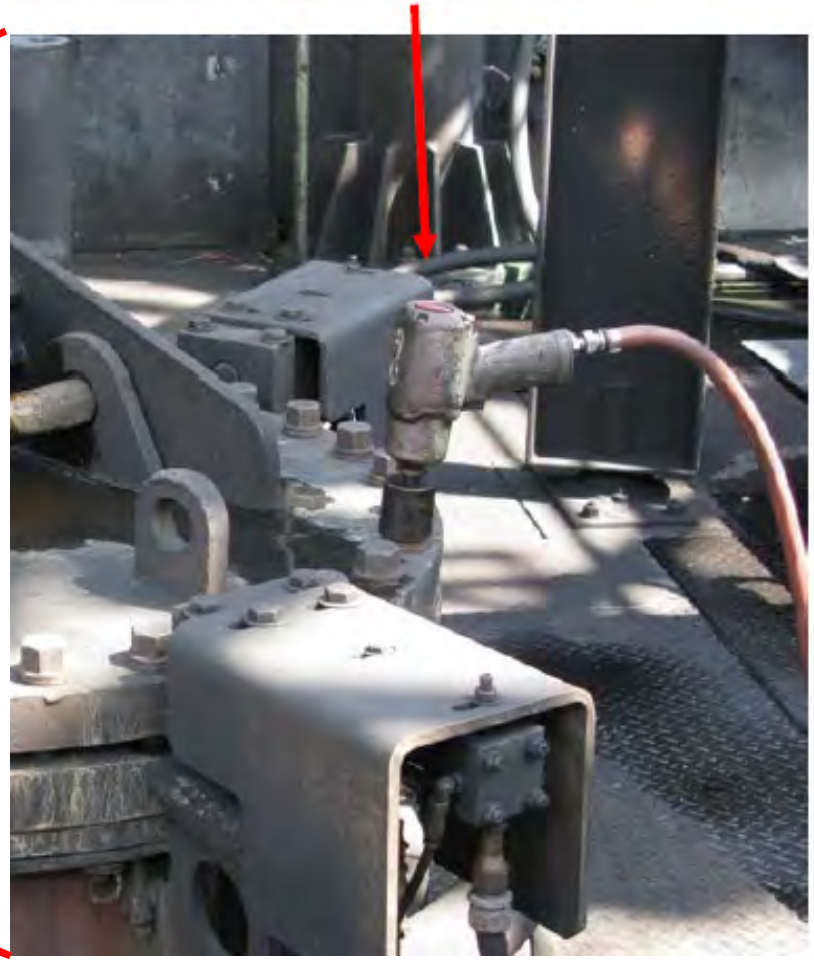
Evolution of Facilities:

(2D) Optimize Size of Pneumatic Wrench



Ingersol-Rand Model
2925 $\frac{3}{4}$-inch

Reduced Size Pneumatic Wrench



Top Head Safety

Evolution of Facilities:

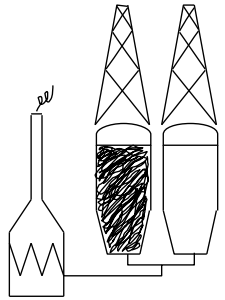
(2D) Pneumatic Wrench Maintenance Reminder

Top Head Safety

Evolution of Facilities:

(3) Figure-8 with Hydraulic Lift

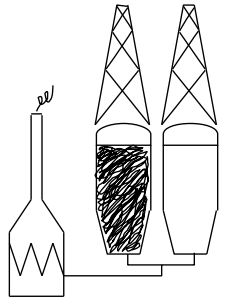
Top Head Safety



Evolution of Facilities:

(3) Figure-8 Bolting Operation

Top Head Safety



Evolution of Facilities:

(3) Drill Stem Guides (aka Bat Wings, Guide Plates, Media Lunas, etc)

Top Head Safety

Evolution of Facilities:

(3a) Top Head Maintenance Trolley

Top Head Safety

Evolution of Facilities:

(3b) Top Head Nut Clips

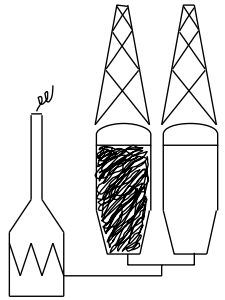
Top Head Safety

Evolution of Facilities:

(3c) Lanyard to prevent falling into top head

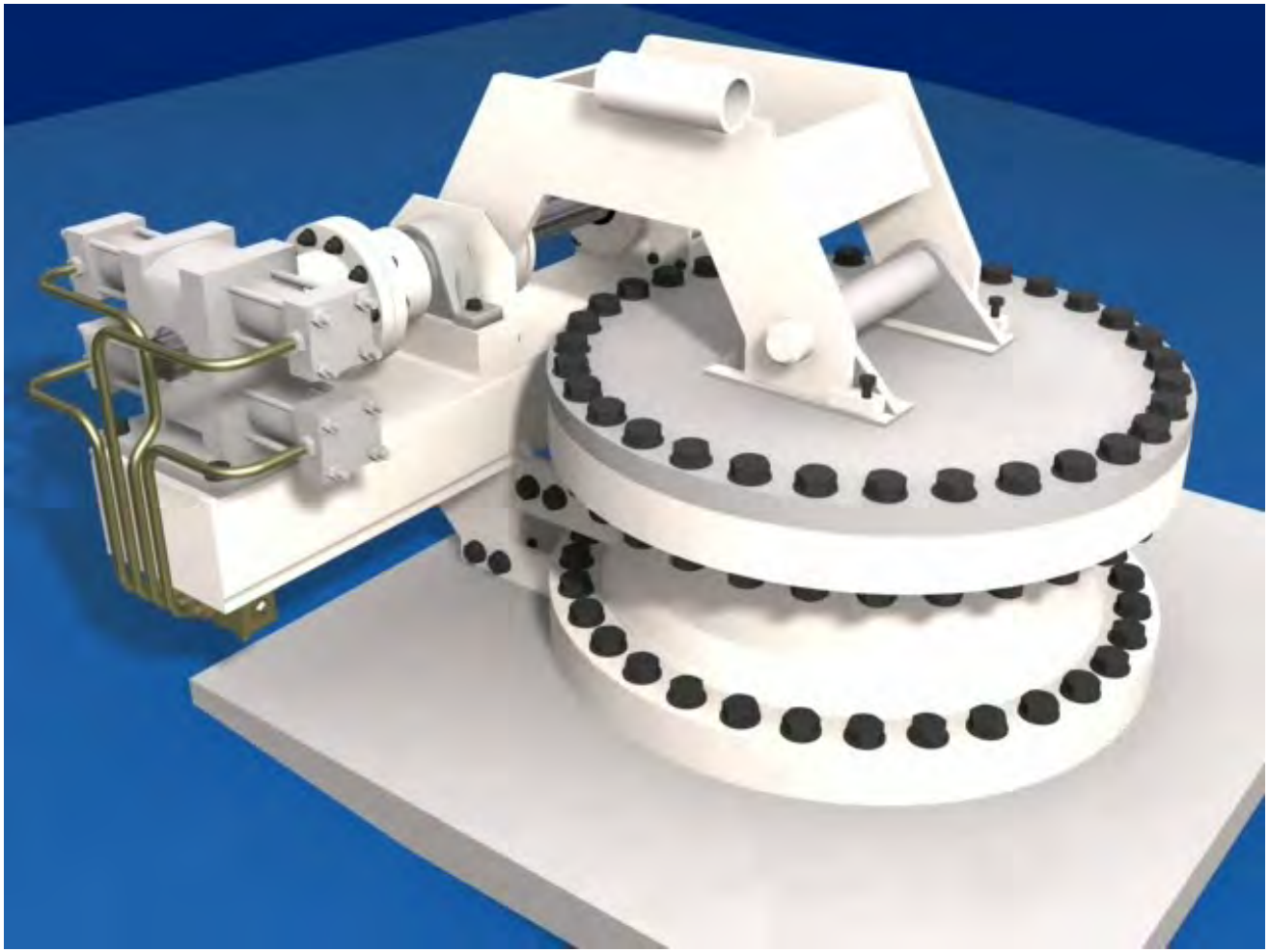
TOR Cable with Gravitational Seat Belt Catch and Lanyard for Worker's Harness

Top Head Safety



Evolution of Facilities:

(4) Swing-Back Hydraulic Top Head*

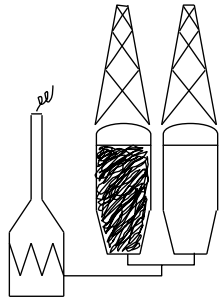


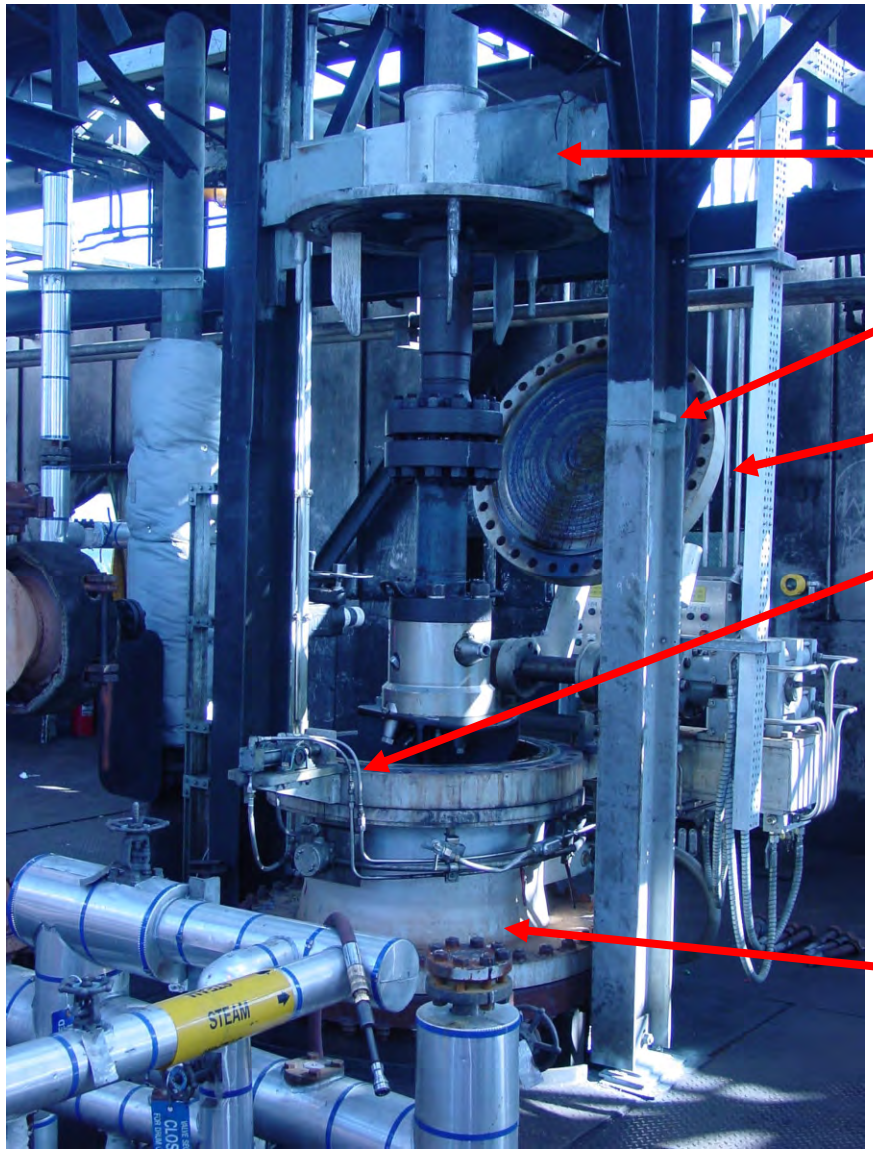
* Foster-Wheeler & Tesco Design

Top Head Safety

Evolution of Facilities

(4) Swing-Back Hydraulic Top Head





Drill Stem Guide Plate Assembly

Extended Guide Rails

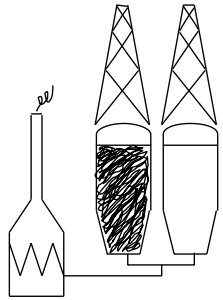
Swing-back Head

One of Three Lock Hydraulic Lock Pins

Elevated Top Head Nozzle

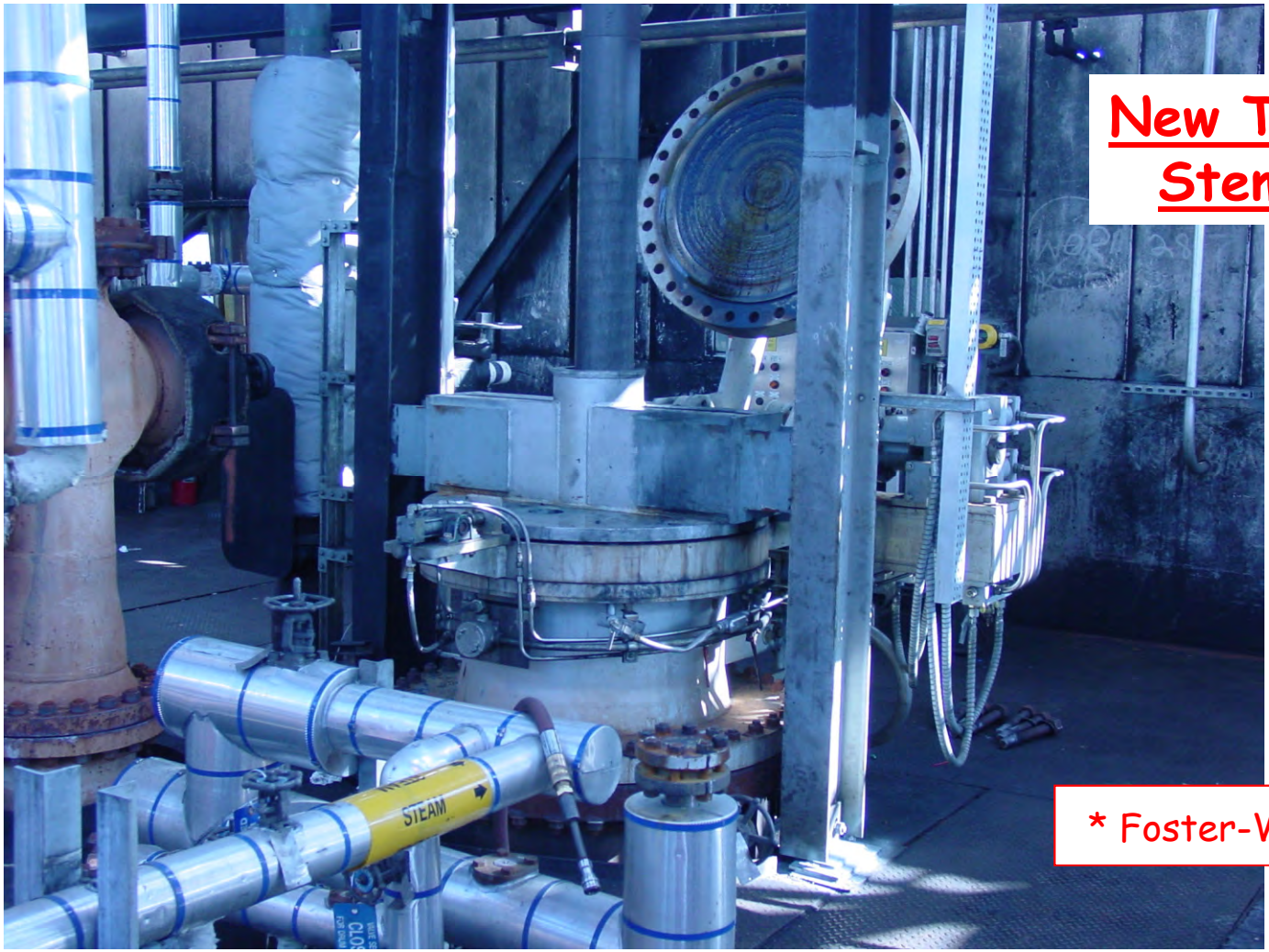
* Foster-Wheeler & Tesco Design

Top Head Safety



Evolution of Facilities:

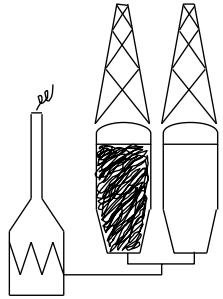
(4) Swing-Back Hydraulic Top Head



New Top Head* – Drill Stem Inserted

* Foster-Wheeler & Tesco Design

Top Head Safety

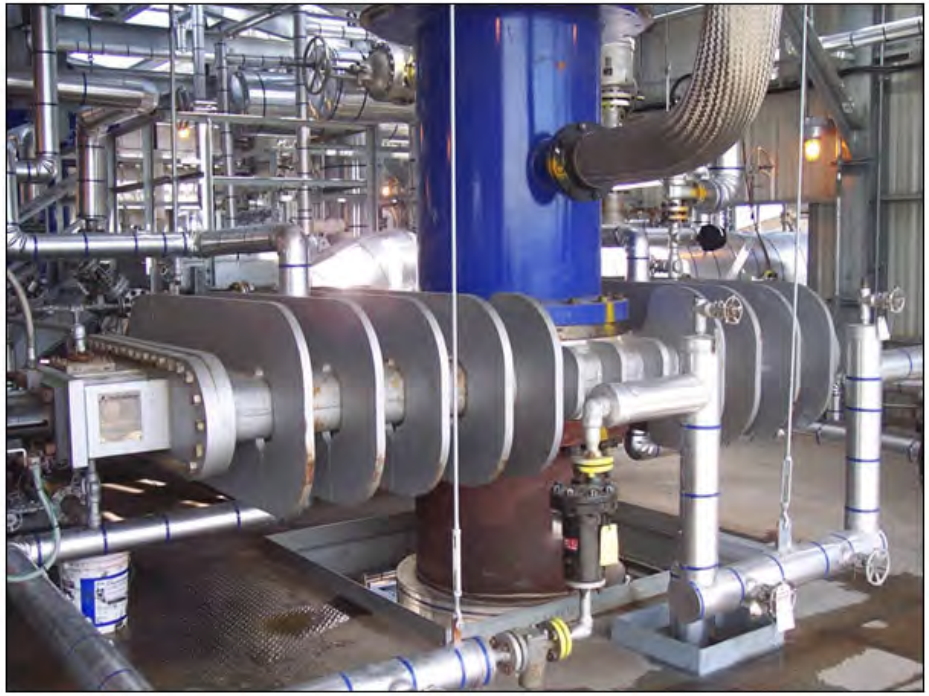


Evolution of Facilities:

(5) Slide Valve

Z&J - BP Lingen Germany 2002

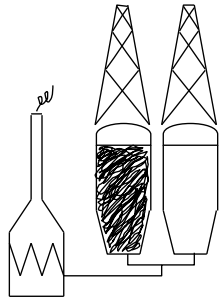
Delta Valve GV830



DeltaGuard® GV830

30" Configuration: L 158 "x W 53 "x H 22 " stiffener to stiffener, L 158 "x W 53 "x H 10 5/8 " face to face

Top Head Safety



XOM Top Head Status:

=> Manually-bolted hoist-operated top head flange & cover (12 drums)
- original design from 1940's and 1950's

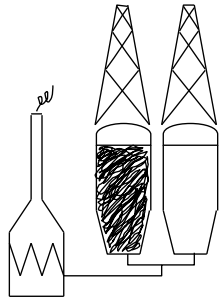
=> Manually-bolted hoist-operated top head flange and clam-shell guide plates (4 drums) - original 1973 design

=> Manually-bolted figure-8 assembly with hydraulic lift at level of top deck platform at one site (2 drums) - original 1983 design

=> Hydraulic-Actuated Swing-Back with Manual Bolting has been installed on four Cokers (2 Sites with total of 18 drums) over the last 6 years, who previously had a simple Manual Bolted Flange at deck level

=> Motorized gate valve below the manually-bolted top head flange is being progressed as a modification to the existing figure-8 assembly with hydraulic lift and elevated top head nozzle

Top Head Safety



Swing-Back Head Learnings

(1) Retrofit Design can have hidden costs.

=> Clearance for the top flange swing radius & raising top head nozzle can require a significant cost adder if the drill stem assembly requires modification

=> Cutting hose hangs lower, which can require cutting deck piping mods

(2) Drum cooling is still a concern relative to bolt removal

=> Attempts to reduce drum cooling following facilities installation can be limited by the need to reduce the top head temperature enough to allow safe manual bolt removal

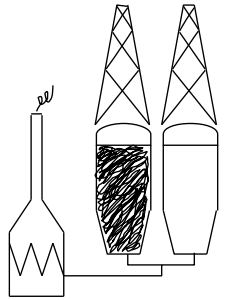
(3) Severe steam blowouts during coke cutting can bend the lock pins that hold the guide plate in place

=> Infrequent drum pressure spikes can be 5 - 10 psig during cutting, which has lifted the guide plate and bent a lock pin

=> Controls are in place to limit the frequency of such events

Top Head Safety

Manual Deheading – Procedure Considerations



Following completion of quenching & depressurization*, having drained the drum at least into the middle of the coke bed, and having met all permissives to allow opening of the coke drum:

(1) Lower the drill stem on top of the top head flange (this prevents release of vapors when removing bolts from the flange connection)

PLEASE NOTE This practice is not recommended by Flowserve. They site increased risk of hoist cable binding and wear associated with retensioning slack cable when the drill stem is raised. Still, this practice has been in place at several cokers for many years without problems. Therefore, it is recommended that the site compare the risks of escaping steam/vapor from the coke drum flange versus the risk associated with creating a slack hoist cable, and select their preferred option.

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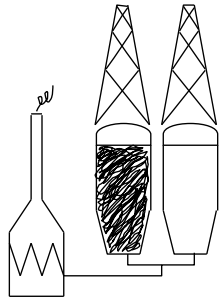
* Hot Bolting is permitted following determination of minimum bolt requirement and a site safety risk assessment.

Top Head Safety

Manual Deheading – Procedure Considerations



(2) If steam evolution is an issue, start top water or top ejector operation

(3) Having donned all required safety gear and attached lanyard to cable, manually unbolt the top head, locating the bolts in a bolt carriage or other holder

(4) Return to cutting shed & raise the drill stem

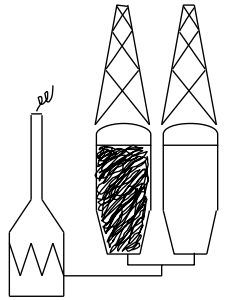
(5) Raise the top head Fig-8 assembly remotely using the hydraulic lifter

(6) Return to top head and manually turn the Fig-8 180 degrees
- the seal plating must be securely fastened with adequate pressure relief gaps that direct geyser steam upward, not sideways.

(7) Take the outage with the guide plates fastened in place using a procedure that minimizes exposure of the operations technician to the open coke drum

Top Head Safety

Manual Deheading – Procedure Considerations

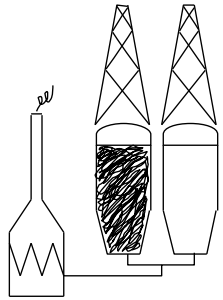


(8) Open the clam shells and lower the drill stem into the drum
- use of a guy-wired drill stem yoke collar guide or a retractable hydraulic guide allows the drill stem to be centered into the drum as it descends and eliminates the need for the operator to be working over the open hot drum as the drill stem is lowered

(9) Close the clam shells and secure in place around the drill stem

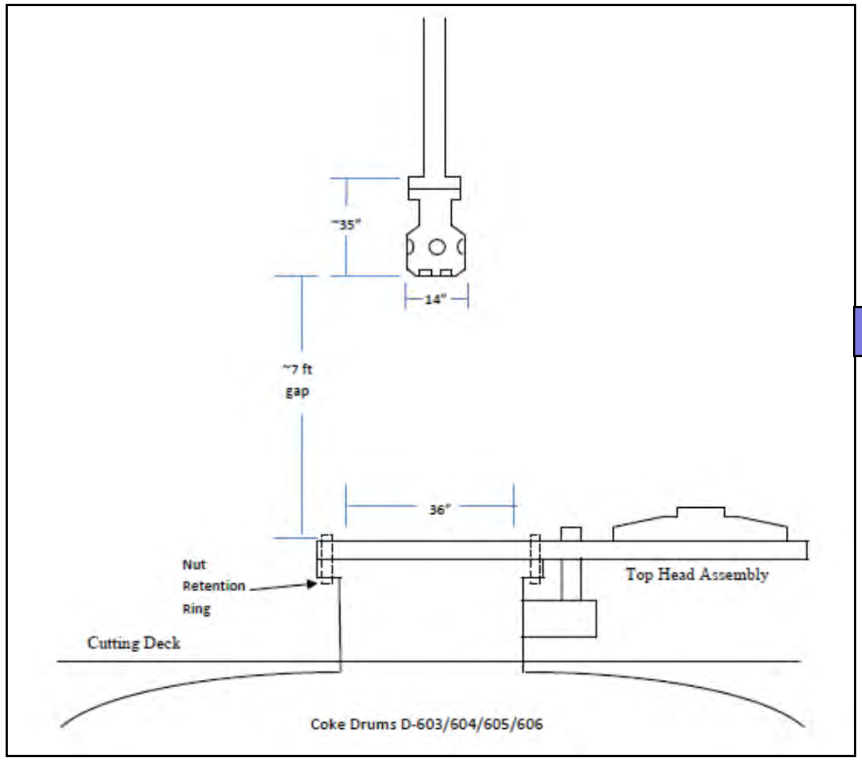
(10) Proceed to coke cutting following bottom unheading operations

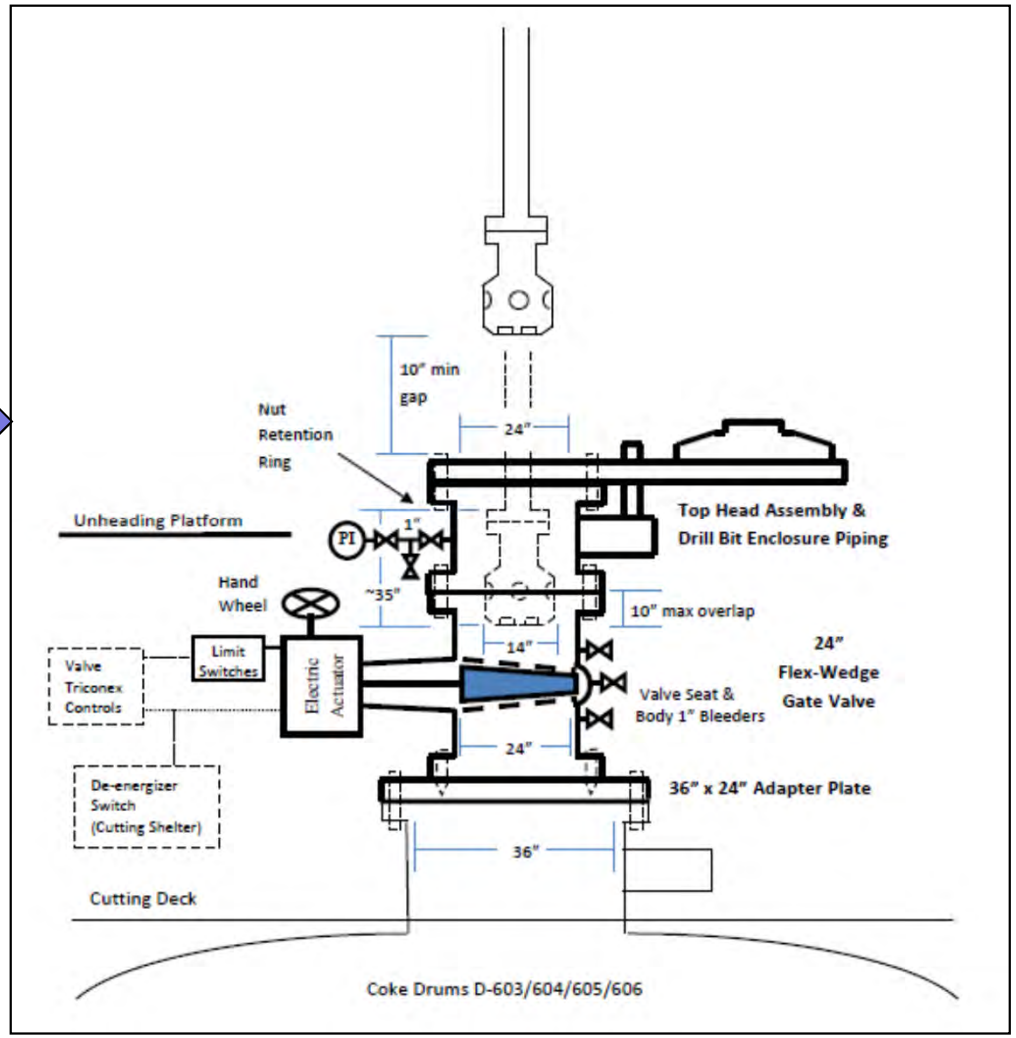
Top Head Safety



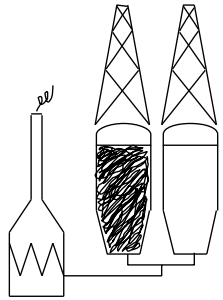
Motorized Gate Valve:

=> Developed by XOM to Economically Mitigate the Risk associated with Coke Drum Boilover





Top Head Safety



Motorized Gate Valve:

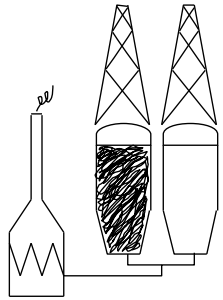
=> Leaves residual risks associated with bolting, unbolting, moving the flange, dealing with stuck drill stems

=> Functionality Risks : valve fouls with hydrocarbon or coke, is deformed by heat or is mechanically unreliable, drill stem alignment

=> Design considerations:

- Hard-piped steam purges are not in place. Instead we are providing nozzle tap connections should they be needed.
  - Steam purge piping appears to create more problems than prevented
  - Impedes access to the top head, increases risk of burns, added maintenance, increased capital cost, increased energy cost, steam condensate to deal with, etc.
- Temperature that the valve will see much less than the 820°F coke drum outlet operating temperature, reducing risk of hard coke forming
- Hermetic sealing in the valve seat not required since the operators will have to wear proper PPE like today.

Top Head Safety

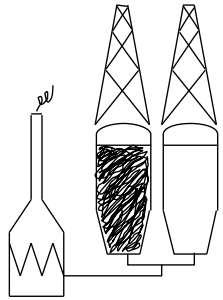


Motorized Gate Valve:

Design considerations (cont'd):

- Mechanical distortion leading to leakage or inoperability
  => Slight leakage is acceptable; body is hard-faced; disc guides provided
- Failure to bleed off pressure prior to unbolting the top flange, causing worker exposure to jetting hot steam
  => Procedural requirement to open the gate valve after vent valves are open, prior to unbolting the top head
  => Installation of a pressure gauge in the space between the gate and top head flange is key indicator for technician
  => Use of proper PPE req'd
- Build-up of high pressure between the valve gate and the top head flange
  => Probability of trapping condensate is low
  => Not possible to build up heat in that volume space since heat loss is greater than heat gain due to high surface area above the gate valve.

Top Head Safety

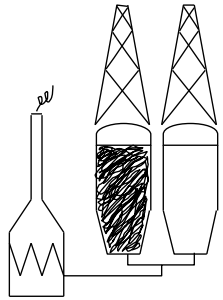


Motorized Gate Valve:

Design considerations (cont'd):

- Unexpected opening of the gate valve after it is closed and workers are working at or around the top head.
  => Low probability of random MOV movement plus a simultaneous water boil over, creates a very low probability
  => Still, procedures will require that the operations technician validate the closed valve position via limit switch checks and then deenergize the MOV.
  => Recent learnings and fixes on Limitorque L120 motor actuator contactor vibration will further reduce the chance of this event.
- Failure of the motor actuator, requiring manual actuation of the valve
  => Use of a pneumatic wrench (nut-runner) will be the back-up to the motor, yielding a 10 minute delay in top head opening operations.

Top Head Safety



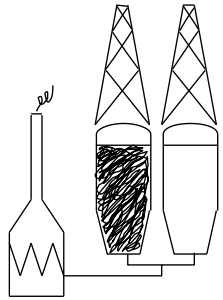
Motorized Gate Valve:

Design considerations (cont'd):

- Lowering the drill stem into the coke drum without damaging gate valve
  => Proximity switches with alarm/cut-out are provided to reduce this probability.
- Failure of the motor actuator, requiring manual actuation of the valve
  => Use of a pneumatic wrench (nut-runner) will be the back-up to the motor, yielding a 10 minute delay in top head opening operations.
- Inability to access the top dome area for inspections
  => The platform, gate valve and extended top head transition piece will need to be removed to allow inspection/repair during shutdowns.
- Injury when working on the top head (unbolting, moving flange plate with hoist, rebolting) from the new elevated platform
- Damage to the slide valve motor actuator during top head tasks, during drill stem segment replacement and maintenance

  => Proper design of the platform relative to worker ergonomics and fall protection is needed to address this risk.

Top Head Safety



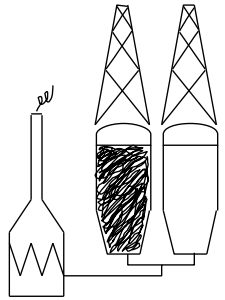
Safe Outage Measurement

Purpose of procedure - eliminate exposure of the operator / coke cutter to the open top head of the coke drum when taking an outage measurement.

Conventionally, the operator must move aside one of the drill stem guide plates and lower a tape measure until it touches the top of the coke bed. This step exposes the technician to the open coke drum (steam and condensate) .

Measuring the Outage

Top Head Safety



Safe Outage Measurement

Procedure - 1

(1) After utilizing their automatic deheading system, the drill stem elevation read out is zeroed at the top flange

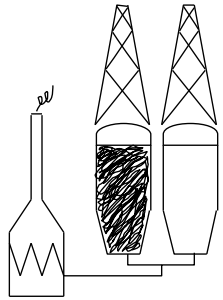
(2) It is then slowly lowered onto the coke bed, no faster than 3 ft/s to avoid excessive cable tension loss when it contacts the coke bed.

=> Contact with the coke bed is indicated by a reduction in cable tension readout by 1500 - 2000 lbs (for example, the tensiometer readout drops from 14,500 pounds to 12,900 pounds).

Yields results within +/- 6 inches of the tape measure

No problems with fouling of the drill stem or Flowserve $\frac{1}{4}$-turn bit, if they slowly contact the drill stem with the coke bed

Top Head Safety

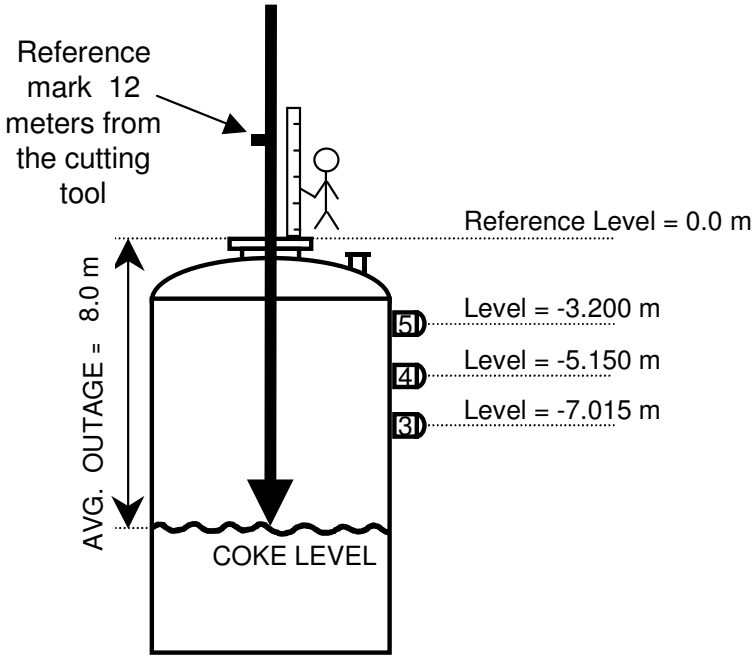


Safe Outage Measurement

Procedure - 2 (for last 10+ years)

(1) The clam shells are secured and bolted around the drill stem

(2) The stem is then slowly lowered onto the coke bed, no faster than 2 ft/s until the cable goes slightly slack



No problems with fouling of the Flowserve $\frac{1}{4}$-turn bit