

# ExxonMobil Beaumont Coker Safety Project



Presented by Robert Mosley of **ExxonMobil**  
@ **Coking.com** March-2008



Prepared by MJ Moloney



## Recognition & Thanks

Foster-Wheeler – Detailed Engineering & Construction Management

Altair Strickland – General Coke Drum Structure Contractor

Mike Alexander – XOM Project Manager

Mike Hillerman – XOM Lead Project Engineer

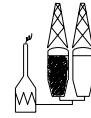
All ExxonMobil Refineries including Bob Blackledge & J Mike Davis

ExxonMobil Research & Eng – Fritz Bernatz, Chris Eppig & Mitch Moloney

All the many subcontractors who made the final project the success that it is

## Beaumont Coker Safety Project

### Coker Overview



#### 8-Drum Coker

- => 48 kBD
- => 18-ft diam coke drums
- => Full Gas Plant
- => BB Shot Coke
- => Coke Pit & Crane
- => Barge Facilities on the Neches River

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## Beaumont Coker Safety Project

### Project Scope



#### Top Deck Upgrade

- => Top Head Handling Device
- => Vent Relocation
- => Cutting Shack Consolidation / Upgrade
- => Safe Outage Measurement
- => Dual cutting water drill stem elevation trips maintained

#### Valve Automation & PLC Interlock

- => Feed & Decoking Utility Lines
- => Double Blocks & Steam Purges

#### Bottom Deheading Upgrade

#### Structure Fire Water Deluge System

- => Base Structure Egress very good - no change needed

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## Beaumont Coker Safety Project

### Overall Project Execution



#### Timeline

- 2002 HAZOP identified two general risks
  - + Furnace shutdown system out-of-date
  - + Manual Structure Valve operations
- 1H04 Operations Team reviewed & quantified Safety Event History
- 2H04 Detailed Safety Risk Assessments performed and documented
- Jan-05 Fulltime BCSP Project Team formed
- Jun-05 Detailed Engineering started in Foster-Wheeler offices
- Sep-06 Field Engineering Started at Coker
- May-07 Coker Turnaround Underway
- Jul-07 Two trains on oil →
- Aug-07 All four trains on oil



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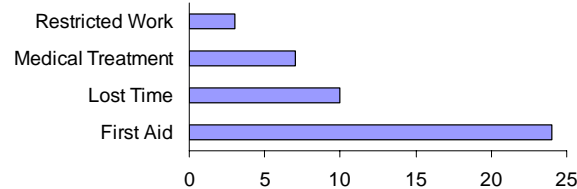
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## Beaumont Coker Safety Project

### Analysis of Beaumont Injury History



#### Coke Drum Structure Injuries (1986-1993) By OSHA Classification



44 injuries analyzed from 1986 through 1993

Ten lost time injuries:

- Four sprains (3 back, 1 ankle)
- Three eye injuries (foreign body)
- Two contusions:
  - Large chunk of coke fell from bottom head and struck operator
  - Impact socket broke and struck operator
- One thermal burn: gush of hot water from bottom head

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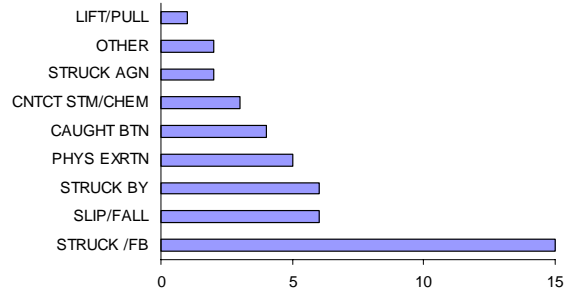
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### Analysis of Beaumont Injury History



Coke Drum Structure Injuries (1986-1993)  
By Type of Event



- Foreign body eye injuries common due to frequent use of air tools
- Strains/sprains common due to manual drum switching

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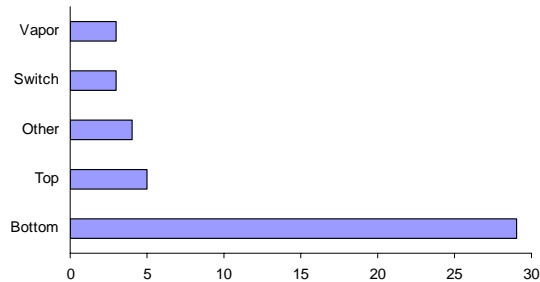
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### Analysis of Beaumont Injury History



Coker Drum Structure Injuries (1986-1993)  
By Location



- Heaviest manual labor occurs on bottom deck

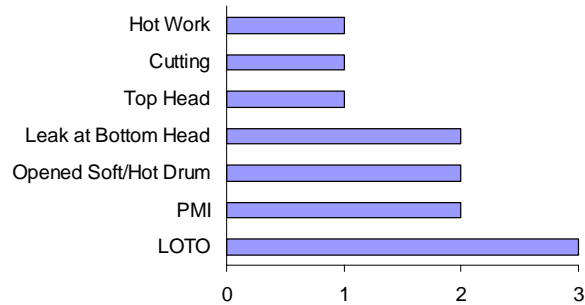
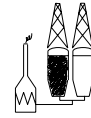
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### Analysis of Industry Major Incident History



- 12 major incidents reported in last 11 years
  - Excludes incidents that occurred away from the coke drum structure
- Most common cause of serious incidents is poor LOTO procedures
  - Valve automation/interlock can reduce this risk
- Both bottom head leaks occurred with automatic deheading equipment

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### Old Top Head Operations



Unbolting the top head



Removing the top head

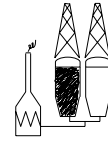
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### Old Top Head Operations



Drill Stem in Place



Measuring the Outage

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### Top Head Hazards Review Summary



Risks: Eruption of hot water / steam / vapors while at top head  
+ Eruptions unpredictable; residual water can contact a hot spot at any time  
Fall Hazard

#### Pre-BCSP Safeguards:

- + Choose crudes mix to avoid hot drums
- + Coke bed quenching overly-conservative  
5.5 hr quench, 240 kgal water with 2 hr of water over
- + Drain all water before deheading
- + PPE (raingear) during unheading

#### Pre-BCSP Incidents:

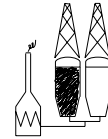
- + 1985 fatality at Beaumont
- + 1999 near miss at Beaumont
- + 2001 fatality at Veba Oel in Germany

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### 1985 Fatality Operator Burned by Hot Water Eruption

- + # 1 Drum properly vented
- + All valves in proper position
- + Drum cooled properly (< 200°F, 0 psig)
- + Drum full of water
- + Top Head unbolted and lifted to one side
- + Operator was walking to other side when water erupted

Root Cause - Boil Over due to water seeping into an unquenched hot spot

Follow-up - Drain before dehead and very conservative quench procedures

### 1999 Near Miss Hot Drum Prior to Deheading

- + #1 Drum cooled, vented and drained per procedures
- + Top head hot bolted, not removed
- + Drum temperature spiked to 500°F, steam/vapors whistling from vent / flange
- + Lasted 15 minutes

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### Automatic Top Head Handling Device

Goal => Eliminate worker exposure to an open top head as part of routine operations

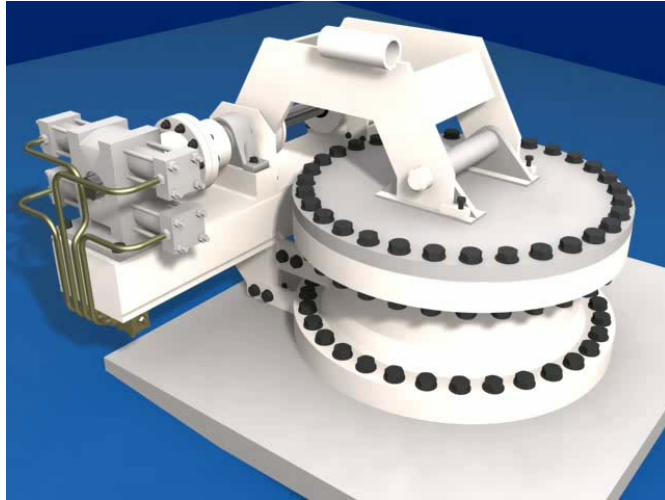
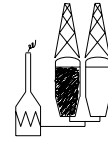
Foster-Wheeler Designed / Tesco Manufactured

Facilities Features:

- + Manual bolt operation
- + ExxonMobil added a Lock Mechanism, good for  $\geq 10$  psig of process pressure during unbolting
- + Swing Back Hydraulically-Actuated Head
- + Drill stem guide plate automatically locked in place
- + Outage taken by lowering drill stem on to top of coke bed using elevation readout and tensiometer
- + Redundant drill stem limit switches used to prevent cutting water from exiting the top head

## Beaumont Coker Safety Project

### New Swing-Back Hydraulic Top Head\*



\* Foster-Wheeler  
& Tesco Design

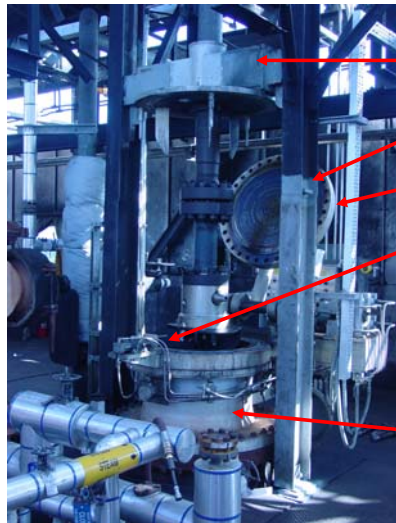
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## Beaumont Coker Safety Project

### New Top Head\* - Drill Stem being Lowered



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

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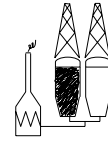
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## Beaumont Coker Safety Project

### New Top Head\* - Drill Stem Inserted



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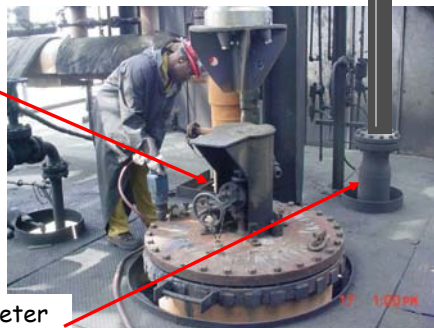
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### Top Deck Safety - Vent Relocation



Previously the coke drum was vented via a 2-inch pipe located directly on the top head

- => Single manual block valve
- => Discharge close proximity to operator



New design enlarged to 6-inch diameter and relocated to side of top structure

- => Two MOV block valves provided with PLC interlock

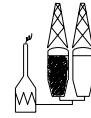
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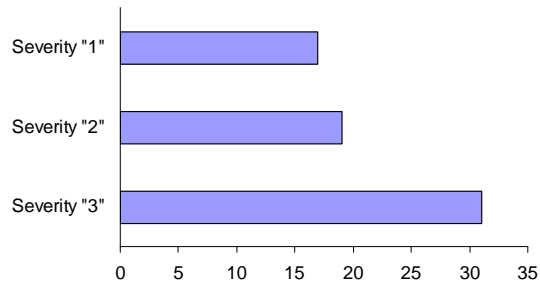
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## Beaumont Coker Safety Project

### Analysis of Beaumont Cutting Shack Risk



Beaumont Hot Drums, Oct-03 to Mar-04



➤ Severity Scale

- Severity "1" = steam out the top head
- Severity "2" = steam and vapors out the top head
- Severity "3" = steam, vapors, and coke balls out the top head

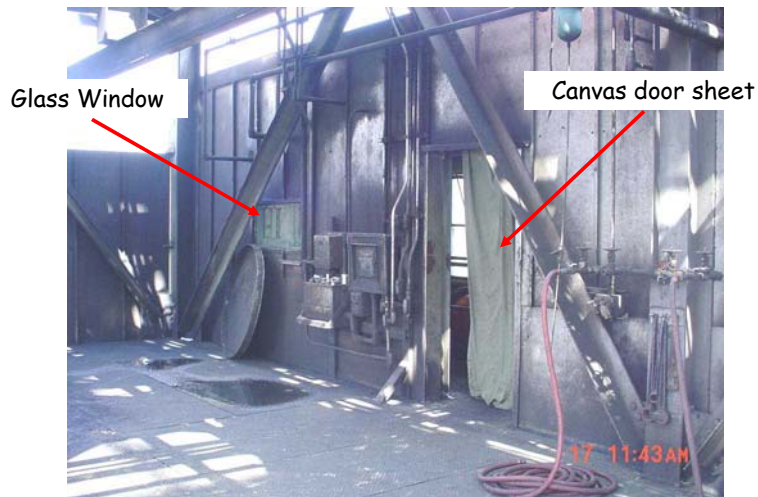
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## Beaumont Coker Safety Project

### Partially Enclosed Cutting Shack



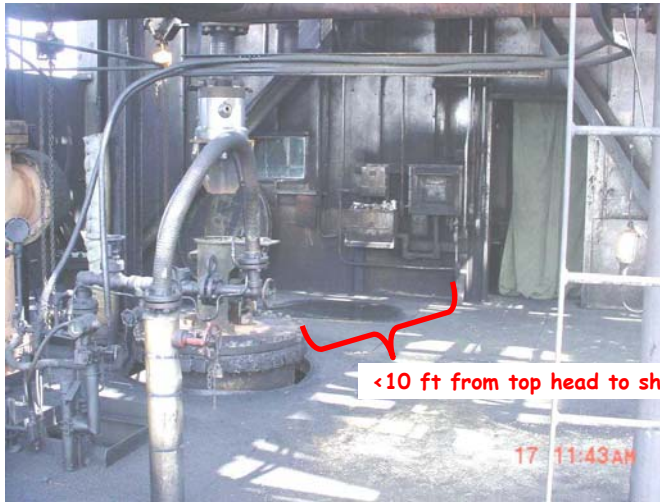
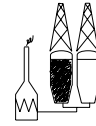
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## Beaumont Coker Safety Project

### Partially Enclosed Old Cutting Shack



<10 ft from top head to shack

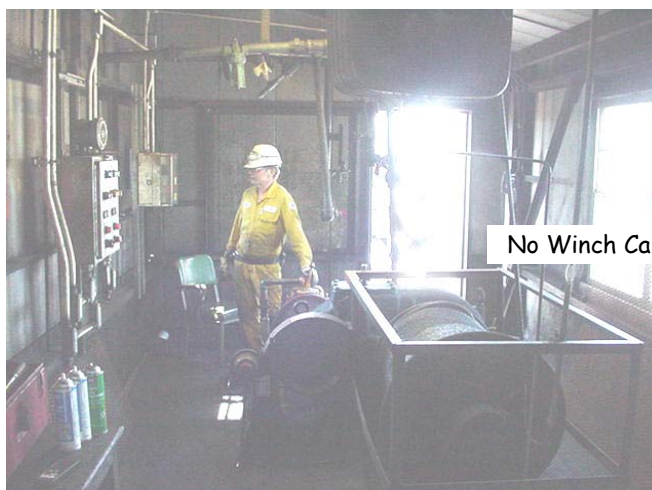
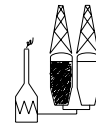
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## Beaumont Coker Safety Project

### Old Cutting Shack - Coke Cutting



No Winch Cable Protection

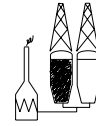
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## Beaumont Coker Safety Project

### Old Cutting Shack - Interior (Another View)



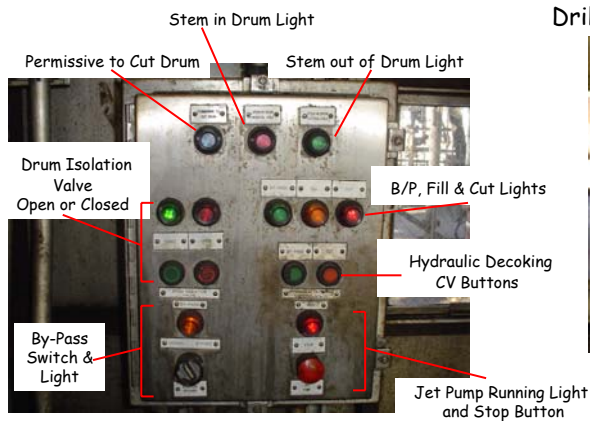
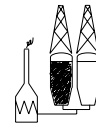
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## Beaumont Coker Safety Project

### Old Cutting Shack - Beaumont's Old Panels



### Drill Stem Depth Monitor



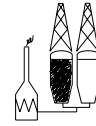
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## Beaumont Coker Safety Project

### Old Cutting Shack - Hot Drum Viewed from Shack



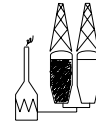
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## Beaumont Coker Safety Project

### Old Cutting Shack - Hot Drum Viewed from Walkway



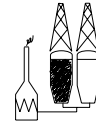
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## Beaumont Coker Safety Project

### New Cutting Shack Control Center:



Goals => Protect coke cutter from heat stress, hot steam, toxic gases, exploding coke, & broken hoist cable

- => Video Camera Surveillance
- => Hydraulic Power Unit & Water Deluge Panel
- => Automatic Top & Bottom Head Controls & Permissives
- => Protective Glass
- => Jet Water Pump Panel
- => Coke Drum Cutting Controls & Monitoring Panels
- => Redundant UPS Systems
- => HVAC, Pressurization, Gas Detectors, Alarms for H2S & HC
- => Acoustic Monitoring of Coke Cutting - Patent Pending
- => Cable Winches outside of Control Center in old shacks
- => Modular Design

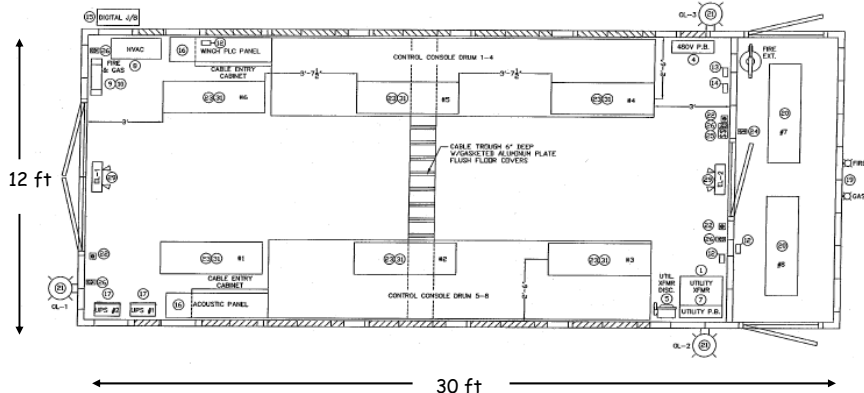
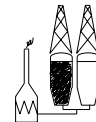
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## Beaumont Coker Safety Project

### New Cutting Shack Layout

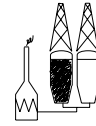


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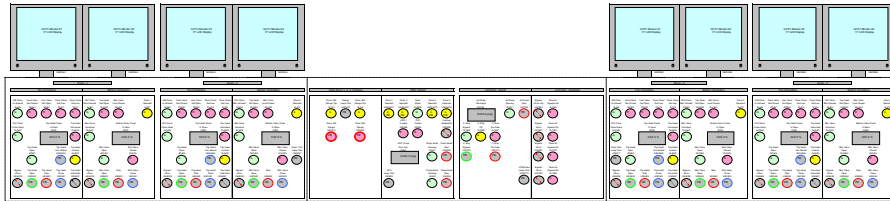
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# Beaumont Coker Safety Project



## New Cutting Shack Layout

- 8-Drum Coker
- These are the displays on one side of the cutting shack (drums 1-4):



#1	#1	#2	#2	Water	HPU	Jet	Jet	#3	#3	#4	#4
Auto	Auto	Auto	Auto	Deluge		Pump	Pump	Auto	Auto	Auto	Auto
Top	Bottom	Top	Bottom			Controls	IL's	Top	Bottom	Top	Bottom
Head	Head	Head	Head					Head	Head	Head	Head

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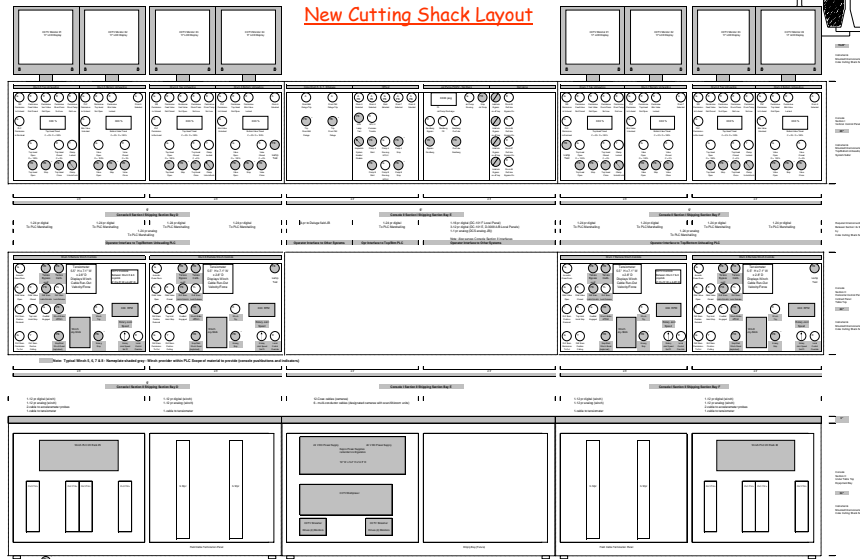
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## New Cutting Shack Layout



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### Safe Outage Measurement

Conventionally, the operator must move aside a drill stem guide plates and lower a tape measure until it touches the coke bed

=> Potential exposure to a boil over, where the coke bed shifts (partially collapses), contacting remnant quench water with 600 - 800°F coke; vaporizing steam lifts hot water out of the coke drum.

Use of automatic cutting bit elevation indication and drill stem tension reads out in the centralized shack

Drill stem elevation read out is zeroed at the top flange, then slowly lowered, no faster than 3 ft/s, until 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).

BEA has had no problems with fouling of the drill stem, if they slowly contact the drill stem with the coke bed.

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### New Cutting Shack Layout

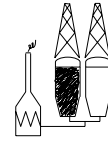
#### Jet Pump Panels - Up Close



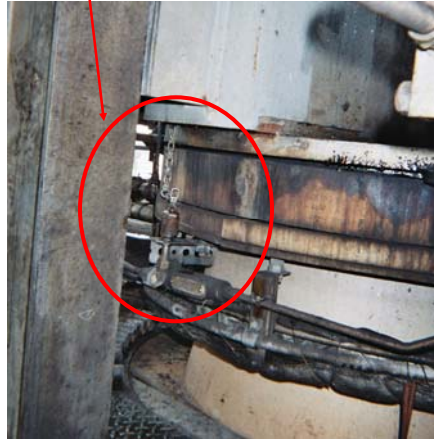


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### Dual Proximity Switch Protection for Cutting Water



"Cow Bell" - Back-up Proximity Switch



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### New Flowserve IR Cutting Winches



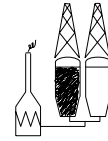
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## Beaumont Coker Safety Project

### Coke Drum Structure - Valve Operation Hazards



Risks: Fire/Explosion/Environmental Release due to an improper valve setup

Pre-BCSP Safe Guards:

- ✓ Training - Primary line of defense for all-manual valve operation
- ✓ LOTO system for drums that are being decoked
- ✓ High Experience Level (but decreasing in the future)

Incidents just prior to BCSP:

- => Hydrocarbon vapors vented to atmosphere
- => Out-of-service drum was vented to atmosphere
- => Vapors backed into the drum from the blowdown system due to single block valve

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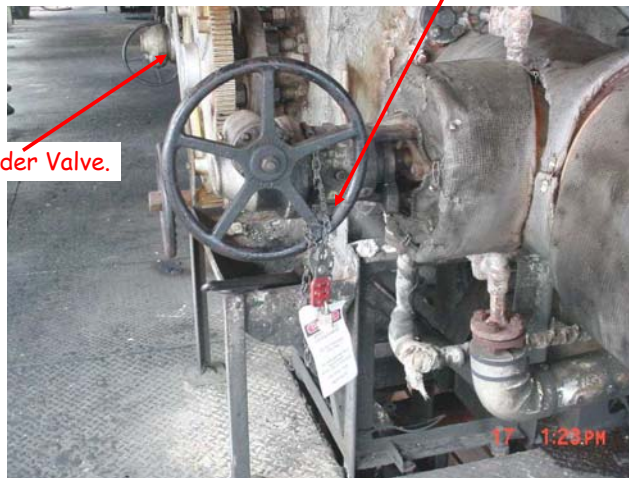
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## Beaumont Coker Safety Project

### Pre-BCSP Structure Valves - Feed Valve LOTO



Wilson-Snyder Valve.



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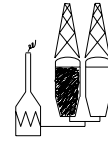
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## Beaumont Coker Safety Project

### Structure Valve Risk Review

- => Feed & Switch Valves
- => Feed & Utility Header Valves
- => Drain & Warm-Up Condensate Valves
- => Overhead Vapor Valves
- => Blowdown Vapor Valves
- => Vent Valves
- => Antifoam Valves
- => PRV Block Valves
- => Water Over Valves
- => Switch & Recirculation Valves



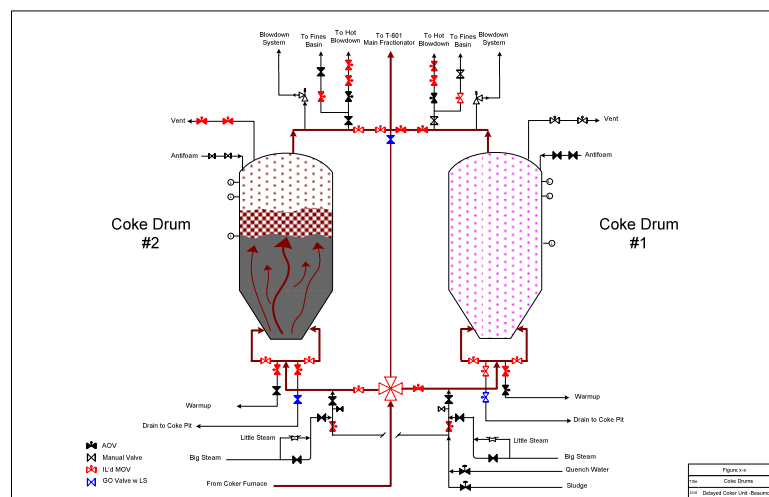
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## Beaumont Coker Safety Project

### Post-BCSP Structure Valves Schematic



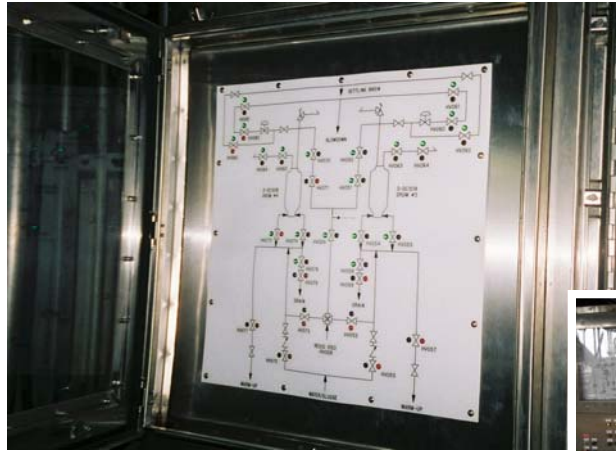
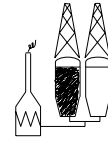
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## Beaumont Coker Safety Project

### Structure Valve Automation - Position Schematic



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### Structure Valve Automation - Schematic & Lockout Panel



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### Structure Valve Automation - Switch Valve Deck



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### Structure Valve Automation - Automated Feed Valves



Bottom Head Deck - Coke Drum Feed Lines - 2 Views



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### Structure Valve Automation - Vapor Deck



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## Beaumont Coker Safety Project

### Bottom Deheading Risks



Risks: Operator struck by falling coke or burned by hot water/steam  
=> Fallouts can be unpredictable

Pre-BCSP Safe Guards:

- ✓ BEA formed plug in bottom of coke drum
- ✓ Cart hydraulics operated remotely since late 1990's
  - Risk remains during unbolting as the cart does not hold the head tightly
  - Risk also remains when hooking and raising the coke chute

Periodic coke fallouts

- Mar-04 Coke fallout on #5 drum  
Root cause unknown, increased aromatic binder to prevent reoccurrence
- Feb-04 Coke fallout on #6 drum  
Fallout occurred following onstream decoking of the West furnace

Many minor injuries at Beaumont

- Jan-95 Employee lacerated by chain during hoisting
- Sep-03 Foot pinched between moving cart and deck (near miss)

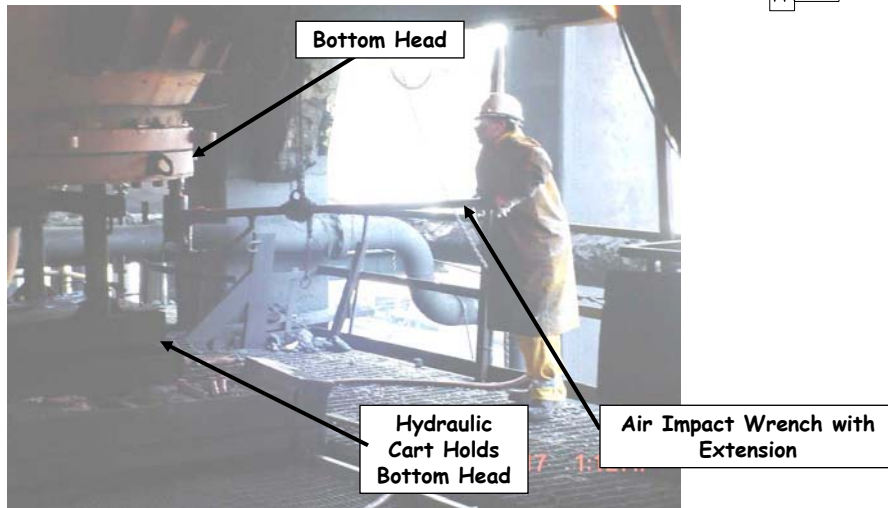
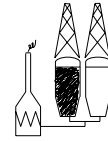
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## Beaumont Coker Safety Project

### Bottom Deheading Pre-BCSP - Unbolting Head



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### Bottom Deheading Pre-BCSP - Lowering Head



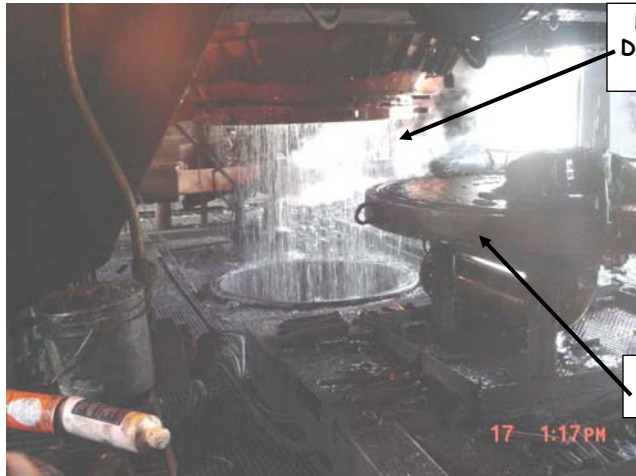
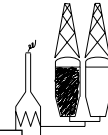
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## Beaumont Coker Safety Project

### Bottom Deheading Pre-BCSP - Moving Head on Cart



Hot Water  
Draining from  
Drum

Head Moved to Side  
on Cart

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## Beaumont Coker Safety Project

### Bottom Deheading Pre-BCSP - Preparing Chute



Hooking Chain  
to Coke Chute

Open Chute is  
Fall Hazard

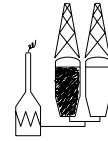
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**Beaumont Coker Safety Project**  
**Bottom Deheading Pre-BCSP - Raising Chute with Air Hoist**



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**Beaumont Coker Safety Project**  
**Bottom Deheading Pre-BCSP - Ready for Cut**



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**Beaumont Coker Safety Project**  
**Coke Fallout at Baton Rouge**



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**Beaumont Coker Safety Project**  
**Coke Fallout at Baton Rouge - Clean-up**



**High risk of  
slips, trips, &  
further fallout**

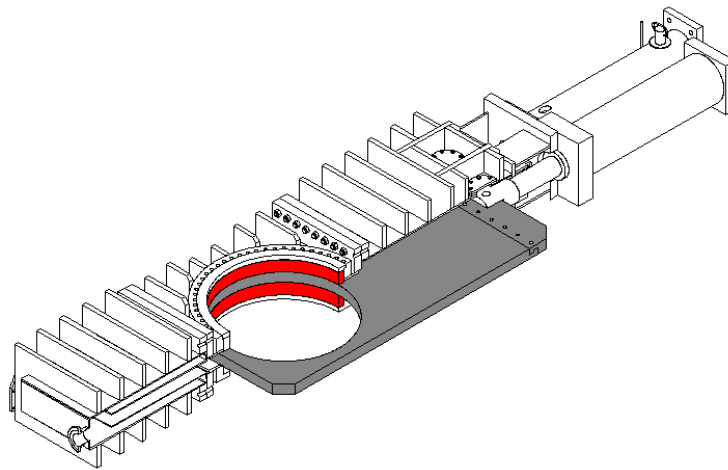
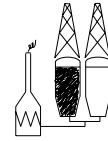
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## Beaumont Coker Safety Project

### Delta Valve Schematic



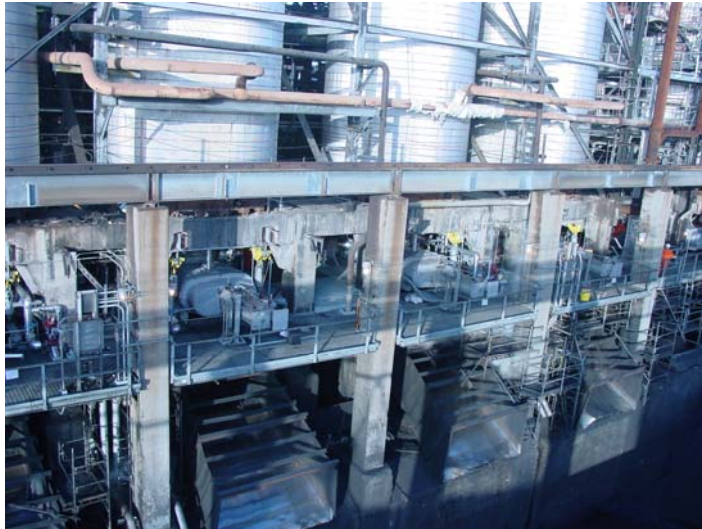
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## Beaumont Coker Safety Project

### Delta Valve Installations & Cutting Chutes



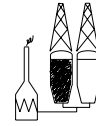
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# Beaumont Coker Safety Project

## Top & Bottom Head Control Panels - Up Close in Cutting Shack



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# Beaumont Coker Safety Project

## Hydraulic Power Unit (1 of 2)



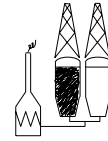
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## Beaumont Coker Safety Project

### Fire Fighting Risk Review



**Risk: Inadequate ability to deal with a major fire at the coker**

Process conditions at coker exceed autoignition temperature, fires relatively common

Pre-BCSP Safeguards:

- => Hose reels are the only water supply on structure
- => 35-lb hand-carried fire extinguishers also in place

Incident Review

Numerous fires on flanges and lines:

- => Feb-04 Flange fire on oil inlet line to #7 drum
- => Jun-98 Anti-foam injection line caught fire on #2 drum
- => Jan-95 Flange fire on oil inlet line to #8 drum

## Beaumont Coker Safety Project

### Fire Fighting Risk Review

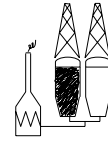


Hose Reel on Cutting Deck



## Beaumont Coker Safety Project

### Automated FireWater Deluge System Design



Design objectives:

- (1) Limit equipment damage from fires  
and
- (2) Allow safe egress from the structure.

=> ExxonMobil approach is:

- Rely on redundant safe emergency egress options
- Design for equipment protection
- Accept secondary personnel benefits during a fire

## Beaumont Coker Safety Project

### Automated FireWater Deluge System Design

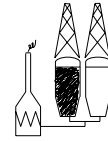


Zones Protected:

By Drum Pair

- + HC Piping & Valves operating above autoignition temperature
    - + Bottom Head Deck
    - + Switch Deck
    - + Vapor Deck
    - + Top Cutting Deck
  - All egress stairways (sprays should be provided at the egress points from all protected areas, at a minimum; additional can be provided at the discretion of the site)
  - Hydraulic systems not done because remoted at grade
- => No deluge coverage is typically applied to the coke drum flanges, since those fires would be fought with fixed monitors or high pressure hoses

## Beaumont Coker Safety Project Firewater Deluge - Nitrogen Lines



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## Beaumont Coker Safety Project Firewater Deluge - Emergency Pull Down Boxes



N2 Supply & Fusible Links



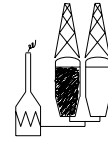
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## Beaumont Coker Safety Project

### Automated FireWater Deluge System Design



Spray System in Action at ExxonMobil Baytown



The water flows are not a "deluge of cascading water," but rather a steady shower of water to allow escape and fire containment

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## Beaumont Coker Safety Project

### Emergency Egress



**Risks:** Walkways, stairways, and ladders are not shielded from coke drums  
Egress paths may be blocked during a fire

Pre-BCSP Safeguards:

Beaumont has multiple egress paths due to its large size (8 drums)

Top deck example:

- Two stairways, Two ladders
- One crossover to the combination tower

Overall, base egress was assessed to be very good given the large interconnected 8-drum structure

Incidents:

=> No recorded incidents because of egress issues in the past

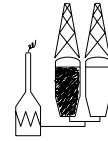
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**Beaumont Coker Safety Project**  
**Emergency Egress - Cross Over Walkway**



Combination Tower



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**Beaumont Coker Safety Project**  
**Emergency Egress - East-West Walkway**



Shack - Drums 5 & 6

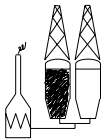


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**Beaumont Coker Safety Project**  
**Mike Hillerman & Robert Mosley on the Job**



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