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

**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
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  - Furnace shutdown system out-of-date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

---

Beaumont Coker Safety Project

**Analysis of Beaumont Injury History**

*Coke Drum Structure Injuries (1986-1993)*

*By OSHA Classification*

- Restricted Work
- Medical Treatment
- Lost Time
- First Aid

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
Beaumont Coker Safety Project

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

Beaumont Coker Safety Project

Analysis of Beaumont Injury History

Coker Drum Structure Injuries (1986-1993) By Location

- Heaviest manual labor occurs on bottom deck
Beaumont Coker Safety Project
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

Beaumont Coker Safety Project
Old Top Head Operations

Unbolting the top head

Removing the top head

Fall Hazard
Beaumont Coker Safety Project
Old Top Head Operations

Drill Stem in Place

Measuring the Outage

Extra PPE required
H2S & vapors

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
   + 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

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

Robert Mosley & MJ Moloney
ExxonMobil
March-2008 coking.com
Beaumont Coker Safety Project

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

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 ≥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

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
Beaumont Coker Safety Project

New Top Head* – Drill Stem Inserted

* Foster-Wheeler & Tesco Design

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
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

Partially Enclosed Cutting Shack

Glass Window
Canvas door sheet
**Beaumont Coker Safety Project**

**Partially Enclosed Old Cutting Shack**

- <10 ft from top head to shack

**Beaumont Coker Safety Project**

**Old Cutting Shack - Coke Cutting**

- No Winch Cable Protection
Beaumont Coker Safety Project
Old Cutting Shack - Interior (Another View)

Beaumont Coker Safety Project
Old Cutting Shack - Beaumont's Old Panels

Drill Stem Depth Monitor

Permissive to Cut Drum
Stem in Drum Light
Stem out of Drum Light
Drum Isolation Valve - Open or Closed
By-Pass Switch & Light
B/P, Fill & Cut Lights
Hydraulic Decoking CV Buttons
Jet Pump Running Light and Stop Button
Beaumont Coker Safety Project

Old Cutting Shack - Hot Drum Viewed from Shack

Beaumont Coker Safety Project

Old Cutting Shack - Hot Drum Viewed from Walkway

Coke Cutter Location
**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

---

**Beaumont Coker Safety Project**

**New Cutting Shack Layout**

---

Robert Mosley & MJ Moloney
ExxonMobil
March-2008 coking.com
**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):

![Diagram of Cutting Shack Layout]

---

Robert Musley & MJ Mainsley  
ExxonMobil  
March-2008 coking.com  
28
Beaumont Coker Safety Project

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.

Beaumont Coker Safety Project

New Cutting Shack Layout

Jet Pump Panels - Up Close
Beaumont Coker Safety Project

Dual Proximity Switch Protection for Cutting Water

"Cow Bell" - Back-up Proximity Switch

New Flowserve IR Cutting Winches
**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

---

**Beaumont Coker Safety Project**

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

*Wilson-Snyder Valve.*
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
Beaumont Coker Safety Project

Structure Valve Automation – Position Schematic

Beaumont Coker Safety Project

Structure Valve Automation – Schematic & Lockout Panel
Beaumont Coker Safety Project
Structure Valve Automation - Switch Valve Deck

Beaumont Coker Safety Project
Structure Valve Automation - Automated Feed Valves
Bottom Head Deck - Coke Drum Feed Lines - 2 Views
Beaumont Coker Safety Project
Structure Valve Automation – Vapor Deck

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)
Beaumont Coker Safety Project
Bottom Deheading Pre-BCSP – Unbolting Head

Hydraulic Cart Holds Bottom Head
Air Impact Wrench with Extension

Beaumont Coker Safety Project
Bottom Deheading Pre-BCSP – Lowering Head
Beaumont Coker Safety Project
Bottom Deheading Pre-BCSP – Moving Head on Cart

- Hot Water Draining from Drum
- Head Moved to Side on Cart

Beaumont Coker Safety Project
Bottom Deheading Pre-BCSP – Preparing Chute

- Hooking Chain to Coke Chute
- Open Chute is Fall Hazard
Beaumont Coker Safety Project
Bottom Deheading Pre-BCSP – Raising Chute with Air Hoist

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

Coke Fallout at Baton Rouge

High risk of slips, trips, & further fallout
Beaumont Coker Safety Project
Delta Valve Schematic

Beaumont Coker Safety Project
Delta Valve Installations & Cutting Chutes
Beaumont Coker Safety Project
Top & Bottom Head Control Panels – Up Close in Cutting Shack

Beaumont Coker Safety Project
Hydraulic Power Unit (1 of 2)
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

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

N2 Supply & Fusible Links
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.

---

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

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

Combination Tower

Beaumont Coker Safety Project
Emergency Egress - East-West Walkway

Shack - Drums 5 & 6

Shack - Drums 3 & 4
Beaumont Coker Safety Project
Mike Hillerman & Robert Mosley on the Job