Delayed Coker Safety Benchmarking

Presented by Mitch Moloney of ExxonMobil
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ExxonMobil - Background

We have 7.5 sites and 12 Delayed Cokers

Each of the 12 is Unique

⇒ Age
⇒ Facilities Design
⇒ Feed slate
⇒ Operational experience & training

Each of these sites must assess their operational risk given their unique factors & operating constraints

⇒ Not all cokers need to buy the latest available technology to operate with acceptable operational risks
## Delayed Coker Safety Benchmarking

### Assessing the Risk Probability

1. Assessment of Industry Accidents
2. Review of Plant Safety History
3. Open discussion with operators to determine how often they have made mistakes in routine structure valve operations
4. Risk goes up with high turnover of operations force => need to consider the lowest common denominator

### Human Error Potential (1)

<table>
<thead>
<tr>
<th>Level of Stress</th>
<th>Complexity of Task</th>
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<tr>
<td></td>
<td>Simplest</td>
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<tr>
<td>Low</td>
<td>1 in 10,000</td>
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<tr>
<td>Moderate</td>
<td>1 in 1,000</td>
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<tr>
<td>Emergency, High Stress</td>
<td>1 in 100</td>
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Note 1: Generic human error for various levels of stress and complexity of task.

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## Delayed Coker Automation & Interlocks

### Safety Facilities Considerations

1. Structure Valve Controls
   - Double Block Structure Valves
2. Bottom Deheading
   - Top Deheading
3. Structure Egress
   - Structure Fire Fighting
   - Deluge System
   - Elevators
4. Cutting Shacks
   - Redundant Drill Stem Pump Trips
   - Cutting System Interlocks
5. Anacortes Facilities
   - Emergency Block Valves
   - Safe Draining

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### Delayed Coker Safety Benchmarking

**Facilities Chart @ ExxonMobil**

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<thead>
<tr>
<th>Location</th>
<th>Start-Up</th>
<th>Coke Type</th>
<th>No. of Drums</th>
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<th>4</th>
<th>4</th>
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- Structure Valve Controls
- Double Block Structure Valves
- Top Deheading
- Bottom Deheading
- Structure Bypass
- Steam System
- Structure Fire Fighting
- Cutting Shackles
- Redundant Cutting Pump Trips
- Emergency Block Valves
- Anacortes Prevention Facilities
- Safe Draining

*Post 2007 Turnaround*  
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**Structure Valve Controls**

- Motorized Valves with Redundant PLC-Supervised Interlocks
  - In the least, release of hydrocarbon to atmosphere should be prevented
  - Additional valves should be included based on risk analysis
  - Baton Rouge was the first XOM coker to install such a system on their East Coker in the mid-90's, in response to a fire that caused significant damage when Feed was opened to an open drum
  - Baytown in 2001 because they knew it was the right thing to do
  - Jose Upgrader upgraded their system in 2006
  - Beaumont will start-up in June of this year

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Automation & Interlocks - Valve Risk Review

- Feed & Switch Valves
- Switch & Recirculation Valves
- Feed & Utility Header Valves
- Drain & Warm-Up Condensate Valves
- Overhead Vapor Valves
- Blowdown Vapor Valves
- Vent Valves
- Antifoam Valves
- PRV Block Valves
- Top Water Valves
- Water Over Valves
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Structure Valve Controls
Another Method is Lock-Out Tag-Out (LOTO)
=> In this case, chains and locks are used to prevent opening closed valves at the wrong time
  Locks can also be placed on MOV push button stations to prevent their operation
=> Confirmation by a second field operator or console supervisor, prior to making the valve changes, is required.
=> Sign-off a Check List
There are four XOM sites relying on this system to varying degree:
  Compana, Chalmette, Joliet and Torrance
Company risk analyses show that there is an order of magnitude more risk with LOTO vs MOV / PLC Interlocks

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Structure Valves
Proper Double Block with a Steam Barrier is Essential
=> Our Beaumont Coker actually had some piping line-ups that only had a single block between the process and atmosphere
  This is being fixed as part of their large Safety Project
=> Proper access to the steam and drain valves is essential
=> In one of our older cokers, the spool barrier steam valves for the vapor lines are below the main valve deck and difficult to access
There are four XOM sites relying on this system to varying degree
  Compana, Chalmette, Joliet and Torrance
Company risk analyses show that there is an order of magnitude more risk with LOTO vs MOV / PLC Interlocks

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Structure Valves

Proper Double Block with a Steam Barrier is Essential

Top Deheading

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

Facilities Options:
+ Automatic Slide Valve & Drill Stem Guide
+ Automatic Swing Back, Drill Stem Guide & Manual Bolts
+ Chain Hoist, Manual Scissor Plates, Drill Stem Guide & Manual Bolts

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Top Deheading

Automatic Slide Valve & Drill Stem Guide

Z&J
BP Lingen Germany

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Top Deheading

Automatic Swing Back with Manual Bolts

Schematic with Head in Closed Position

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36 Device at BP
Cherry Point

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Top Deheading

Hydraulic Swivel Lift, Manual Scissor Plates & Manual Bolts

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Top Deheading

+Drill Stem Guide, Cover Plate & Manual Bolts
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Bottom Deheading

Protect against violent or major loss of coke bed:

![Image of coking process]

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Dome Coke Fallouts during Reheading

- The operator was standing behind the feed line as indicated below
- He was hit in the leg
- The total amount of coke that fell filled the area in the picture
- Operators estimate that you could fill 3-4 wheel barrows.
- The piece that struck the operator was 8" by 10" by 2" and weighed ~8 lbs

![Diagram of coke pattern and drums]

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**Bottom Deheading**

Goal: Eliminate worker exposure to an open bottom head as part of routine operations

Facilities Options:

- Automatic Slide Valve (Delta or Z&J)
- Automatic Swing Back (Fluor or Hahn&Clay)
  - Fluor Automatic Remote Chute & Cover
  - H&C Closure Device to replace bolts
  - H&C Telescoping Curtain
- Wheeled Hydraulic Deheading Cart

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**Bottom Deheading**

Automatic Swing Back's

Swing-back deheaders (Fluor-Daniel)  
Retractable deheaders (H&C)

Jose Venezuela  
Chalmette, LA
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Emergency Egress*

⇒ Provide two or more escape routes for personnel at each major coke drum structure working platform

⇒ Escape routes would permit evacuation horizontally to an adjacent structure or to a standoff stairway that can evacuate persons to grade

⇒ Suitable adjacent structures could include other coke drum structures, fractionators, quench blowdown systems, furnaces

* Special thanks to Bob Blackledge of Baton Rouge

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Emergency Egress

Standoff Bridge & Stairway at ExxonMobil Baton Rouge Refinery

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Emergency Egress

Jose Upgrader Protective Shielding Downview

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Automated FireWater Deluge System Design

The design can have one or two objectives:
(1) Limit equipment damage from fires and / or
(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

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Elevator Safety

Eliminate use of the Escape Hatch & Entry into the Shaft
⇒ Trained personnel should move the elevator to a door level
Communication Equipment - Telephone, Radio, PA
Signage with elevator requirements - Inside & Out
⇒ No lanyards ⇒ How-to-Operate ⇒ Emergency ⇒ Load limits
Doors
⇒ Automate Inner & Outer ⇒ Deadman button for closing
⇒ Personnel door on one side & larger Cargo door on the back side
Steam Heaters in Shaft to facilitate cable movement in winter
Dedicated Operator during Turnarounds to enforce safety
Battery-powered back-up Lights
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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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Cutting Shacks

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

Features:
- Pressurization
- H2S & HC Alarms
- Cable winch external to the building
- Protective Glass
- Acoustic Coke Cutting Aids
- Modular Design
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Modular Cutting Shack Design - Up Close

Joliet's Modular Design

Top deck entrance

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Modular Cutting Shack Design - Inside

Joliet's Modular Design

SCBA Escape Pack

Videocamera Display

Coke Cutting Operating Controls

Cutting System Permissives and Operations Status Lights
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Cutting Shocks

Beaumont’s 8-Drum Coker Safety Project

- Video Camera Surveillance
- Hydraulic Power Unit Panel
- Automatic Top & Bottom Head Controls & Permissives
- Water Deluge Panel
- Jet Water Pump Panel
- Coke Drum Cutting Controls & Monitoring Panels
- Redundant UPS Systems
- HVAC, Pressurization, Gas Detectors, Alarms
- Acoustic Monitoring of Coke Cutting - Patent Pending

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Anacortes Facilities

=> Provide an emergency fluid (e.g., water, gas oil, gas, etc.) to ensure coke drum inlet line and coke bed flow channels remain open, IF both steam and regular quench water sources are lost for an extended period of time during a power failure or other similar event.

There are two alternatives:

1. Unplug the feed line when utilities back in service
2. Wait several weeks for the coke drum to cool

This is a low probability event, which makes it difficult to justify an extensive facilities investment.

Several sites have justified connecting firewater via a low cost jumper to their quench water line (requires special controls!)

=> Other sites are living with the alternatives
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Safe Draining Procedures:

Verify & Triple Check for Proper Drain
  + Maintain good steam purge during switch to avoid leaving resid in feed line
  + Visually verify drain rate several times during drain
  + Verify level probes are dropping
  + Verify drain time is normal
  + Add top water at end to visually verify water drain path
  + Measure drain water recovery in tank
  + Drain under mild pressure (optional)

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Safe Draining Facilities:

  + Drain outlet discharge to a safe disposition
    => an area that does not expose workers to the splashing hot water or rising steam.
    => corner of the coke pit or the entrance to the fines lane or labyrinth
  + Drain outlet should not be submerged, allowing visual verification of drain rate
  + Each drum pair should have its own dedicated drain line to avoid overlap of drains with other drums
  + The drain line should be as short and as straight as possible.
  + A clean out connection should be provided in the event of a pluggage.
  + An air/water connection to pull a vacuum on the drain line while breaking the oil inlet/bottom flange.
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ConocoPhillips Numeric Facilities Rating

- 6's (0 to 8 pts)
  - 5 to 7 pts awarded
  - Based on percent completion of items listed by audit
  - 1 - Formal Intactness Audit Completed
  - Unheading (0 to 7 pts)
    1. Remote Top Head opening
    2. Top Head Hydraulic + Top Educer
    3. Automatic Bottom Slide Valve
    4. HIC = Grayloc
    5. Grayloc on feed line only
    6. Manual Cart on Bottom
  - Structure Safety (0 to 7 pts)
    1. Procedural - based on percent completion of items listed by audit
    2. Overhead Support
    3. Fire Extinguisher
    4. Coke Cutting (0 to 5 pts)
      1. Cutting water B. System
      2. Fire Fail Amarror
      3. Operator in aid cable
      4. Fire & Impact Hardened drill carrier

⇒ Maximum score is 28
⇒ Thanks to Bill Burns and Tom Hraban of Conoco-Phillips for permission to present

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Delayed Coker Safety Benchmarking

ExxonMobil Numeric Facilities Rating

- 6's (0 to 8 pts)
  - 5 to 7 pts awarded
  - LOTO w/ COV + CHECKLIST
  - 1 - LOTO w/ Independent Operable
    - Verification
  - 2 - LOTO
  - 0 - Single operator operation
  - Unheading (0 to 7 pts)
    1. Remote & Auto Top head operation
    2. Top Head Hydraulic + Vapors Control
    3. Automatic Bottom Slide Valve
    4. HIC Water Curtain
    5. HIC ramping
    6. Auto Chute - Cool & Grayloc
    7. Remote Swing-back Bottoms Head
    8. Manual Cart on Bottom
  - Structure Safety (0 to 7 pts)
    1. Procedural - based on percent completion of items listed by audit
    2. Overhead Support
    3. Coke Cutting (0 to 5 pts)
      2. Cutting water B. System
      1. Redundant drill stem limit switches
      1. HIC & H2S alarm
      1. Pressure relief valve w/ back up source
      1. Fire Fail Amarror

⇒ Maximum score is 28
⇒ Consistent with Conoco-Phillips System
⇒ ExxonMobil cokers range from 25 to 7, which for the most part is in line with coker risk

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