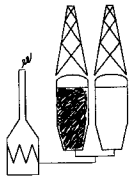
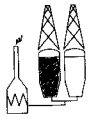
Delayed Coker
Safety Benchmarking



Presented by Mitch Moloney of **ExxonMobil**

@Coking.com May-2007

Delayed Coker Safety Benchmarking



ExxonMobil - Background

We have 7.5 sites and 12 Delayed Cokers

Each of the 12 is Unique

=> Age

=> Facilities Design

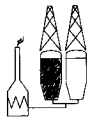
=> Feed slate

=> 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

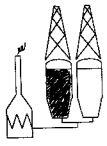
(4) Risk goes up with high turnover of operations force
=> need to consider the lowest common denominator

Human Error Potential (1)

Level of Stress	Complexity of Task			
	Simplest	Routine and Simple	Routine, Require Care	Complicated, non-routine, other duties required
Low	1 in 10,000	1 in 1,000	1 in 100	1 in 10
Moderate	1 in 1,000	1 in 100	5 in 100	3 in 10
Emergency, High Stress	1 in 100	1 in 10 to 1in 1	25 in 100 to 1 in 1	1 in 1

Note 1: Generic human error for various levels of stress and complexity of task.

Delayed Coker Automation & Interlocks



Safety Facilities Considerations

(1) Structure Valve Controls
Double Block Structure Valves

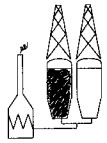
(2) Bottom Deheading
Top Deheading

(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

Delayed Coker Safety Benchmarking



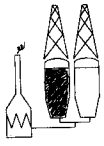
Facilities Chart @ ExxonMobil

Location	BAT-W	BAT-E	BAT-FE	BAY	BEA*	CAM	CHA-1	CHA-2	JOL	JOS	TOR-N	TOR-S
Start-Up	1968	1963	1979	2001	1959	1969	1967	1983	1970	2001	1944	1958
Coke Type	Sponge	Fuels	Mix	Fuels	Fuels	Sponge	Mix	Fuels	Fuels	Fuels	Fuels	Fuels
No. of Drums	2	4	4	4	8	2	2	2	4	4	6	6
Structure Valve Controls	●	●	●	●	●	◒	◒	◒	◒	●	◒	◒
Double Block Structure Valves	●	●	●	●	●	●	●	●	●	●	●	●
Top Deheading	○	●	○	○	●	○	○	◒	○	◒	○	○
Bottom Deheading	○	◒	◒	◒	●	○	◒	●	●	◒	○	○
Structure Egress	●	●	●	●	●	◒	◒	◒	●	●	●	●
Deluge System	●	●	●	●	●	○	○	○	●	○	○	○
Structure Fire Fighting	●	●	●	●	●	●	●	●	●	●	●	●
Cutting Shacks	◒	◒	◒	◒	●	○	○	●	●	◒	○	○
Redundant Cutting Pump Trips	●	○	○	○	●	○	○	○	●	○	○	○
Emergency Block Valves	●	●	●	●	●	●	●	●	●	●	●	●
Anacortes Prevention Facilities	●	●	●	○	●	○	○	○	●	●	○	○
Safe Draining	●	●	●	●	●	●	●	●	●	○	◒	◒

● = yes ◒ = partial ○ = no

* Post 2Q07 Turnaround

Delayed Coker Safety Benchmarking



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

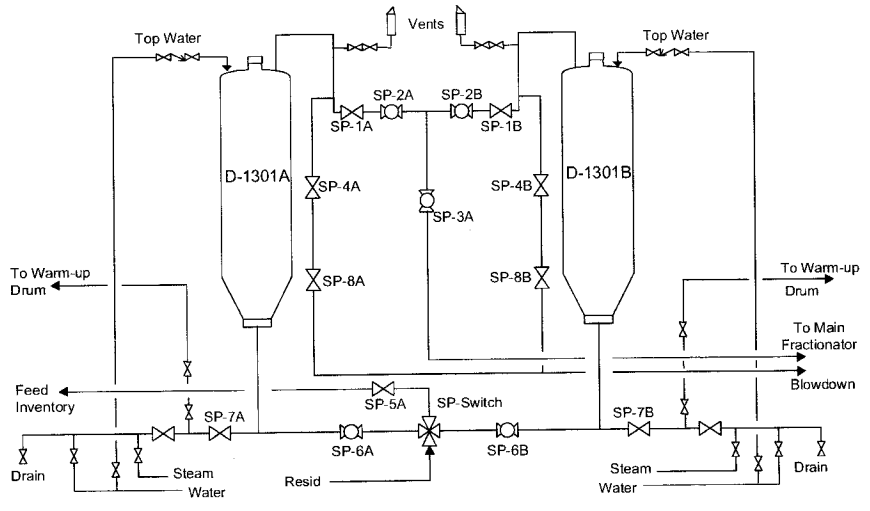
=> Baytown in 2001 because they knew it was the right thing to do

=> Jose Upgrader upgraded their system in 2006

=> Beaumont will start-up in June of this year

Delayed Coker Safety Benchmarking

Automation & Interlocks - Valve Risk Review



Delayed Coker Safety Benchmarking

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

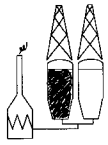
=> Antifoam Valves

=> PRV Block Valves

=> Top Water Valves

=> Water Over Valves

Delayed Coker Safety Benchmarking



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.

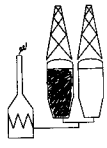
=> Sign-off a Check List

There are four XOM sites relying on this system to varying degree:

Campana, Chalmette, Joliet and Torrance

Company risk analyses show that there is an order of magnitude more risk with LOTO vs MOV / PLC Interlocks

Delayed Coker Safety Benchmarking



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

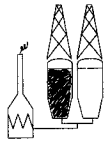
=> In one of our older cokers, the spool barrier steam valves for the vapor lines are below the main valve deck and difficult to access

There are four XOM sites relying on this system to varying degree

Campana, Chalmette, Joliet and Torrance

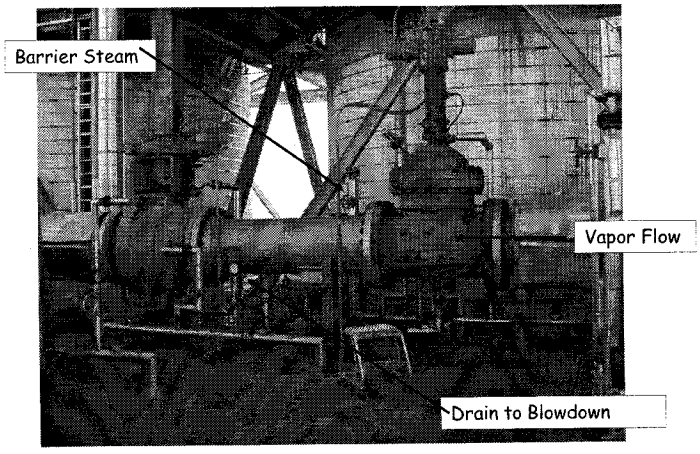
Company risk analyses show that there is an order of magnitude more risk with LOTO vs MOV / PLC Interlocks

Delayed Coker Safety Benchmarking

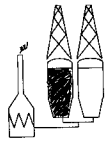


Structure Valves

Proper Double Block with a Steam Barrier is Essential



Delayed Coker Safety Benchmarking



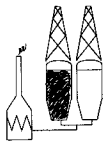
Top Deheading

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

Facilities Options:

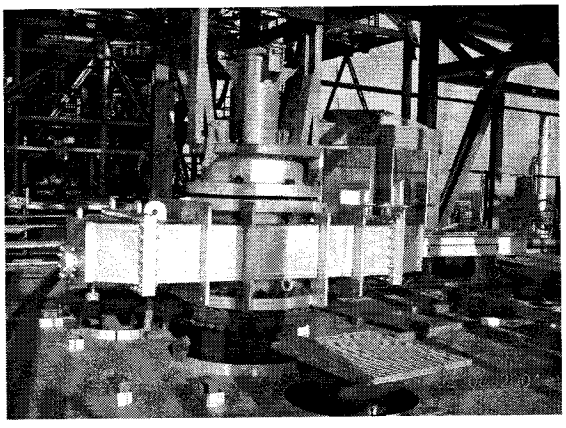
+ Automatic Slide Valve & Drill Stem Guide
+ Automatic Swing Back, Drill Stem Guide & Manual Bolts
+ Hydraulic Swivel Lift, Manual Scissor Plates & Drill Stem Guide & Manual Bolts
+ Chain Hoist, Manual Scissor Plates, Drill Stem Guide & Manual Bolts

Delayed Coker Safety Benchmarking



Top Deheading

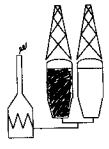
Automatic Slide Valve & Drill Stem Guide



Z&J

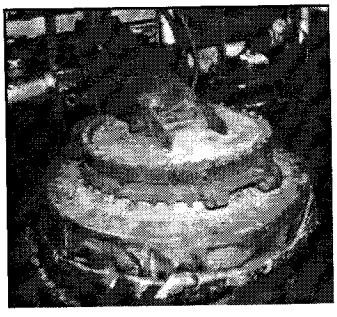
BP Lingen Germany

Delayed Coker Safety Benchmarking

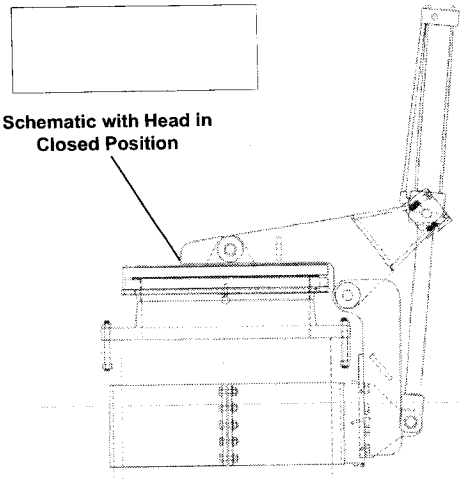


Top Deheading

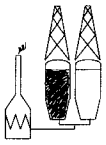
Automatic Swing Back
with Manual Bolts



36" Device at BP
Cherry Point

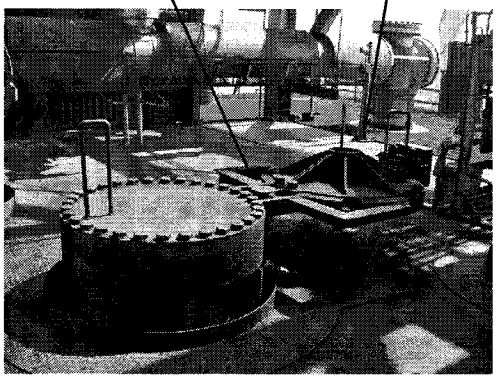


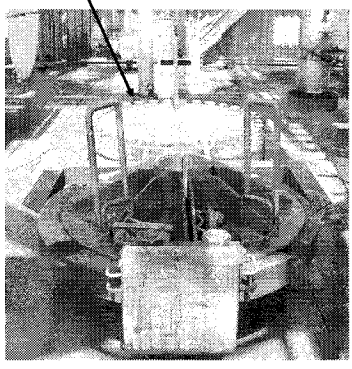
Delayed Coker Safety Benchmarking



Top Deheading

Hydraulic Swivel Lift, Manual Scissor Plates & Manual Bolts





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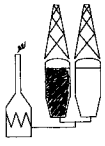
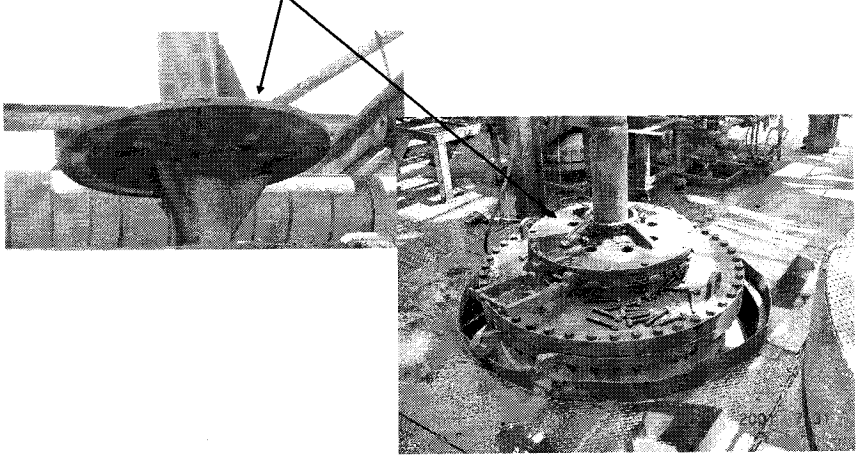
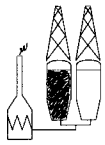


Top Deheading

+Drill Stem Guide, Cover Plate & Manual Bolts



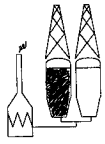
Delayed Coker Safety Benchmarking



Bottom Deheading

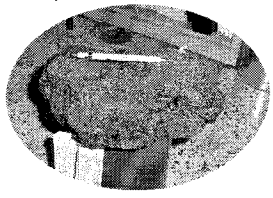
Protect against violent or major loss of coke bed:

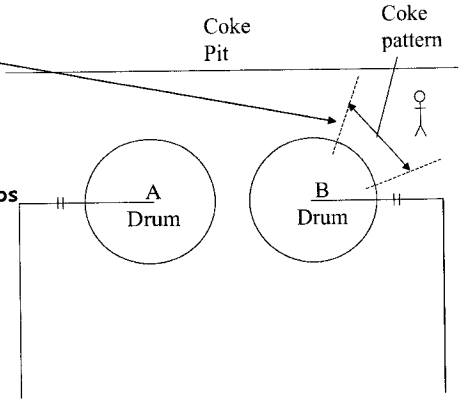
Delayed Coker Safety Benchmarking



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





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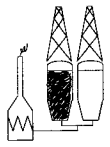


Bottom Deheading

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)

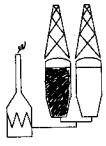
=> Fluor Automatic Remote Chute & Cover

=> H&C Closure Device to replace bolts

=> H&C Telescoping Curtain

+ Wheeled Hydraulic Deheading Cart

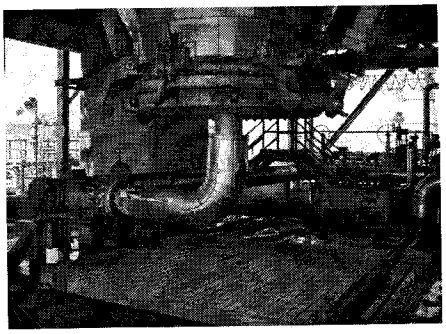
Delayed Coker Safety Benchmarking



Bottom Deheading

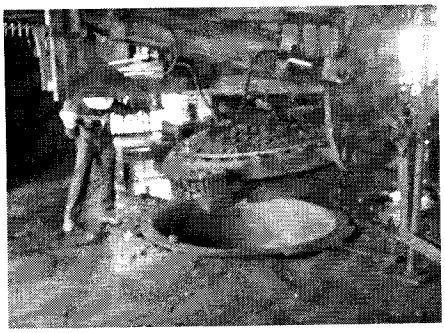
Automatic Swing Back's

Swing-back deheaders (Fluor-Daniel)



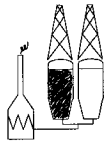
Jose Venezuela

Retractable deheaders (H &C)



Chalmette, LA

Delayed Coker Safety Benchmarking



Emergency Egress*

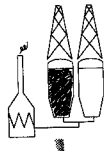
=> Provide two or more escape routes for personnel at each major coke drum structure working platform

=> 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

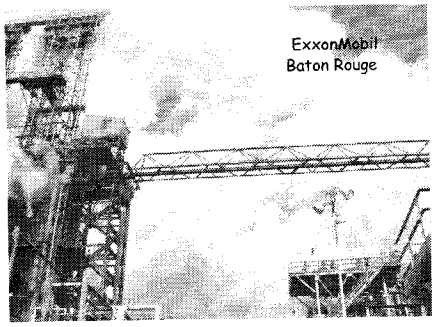
* Special thanks to Bob Blackledge of Baton Rouge

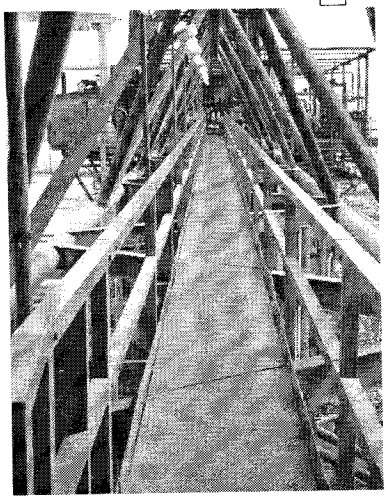
Delayed Coker Safety Benchmarking



Emergency Egress

Interconnecting Stairway Between Coke Drum Structures





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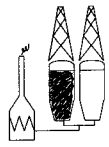
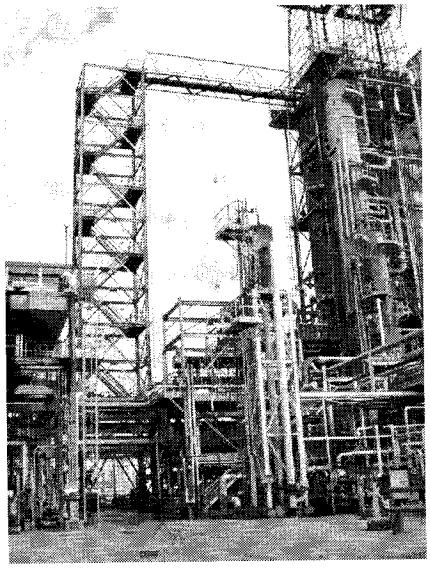


Emergency Egress

Standoff Bridge
&
Stairway
at
ExxonMobil
Baton Rouge Refinery



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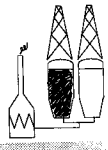
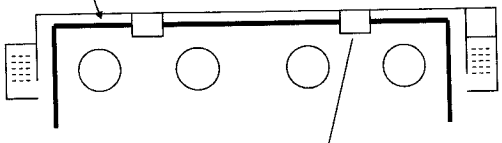
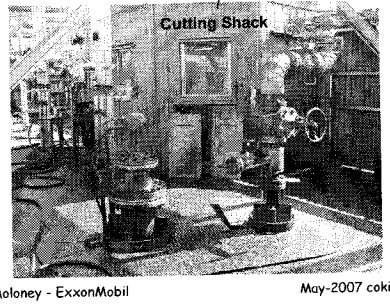
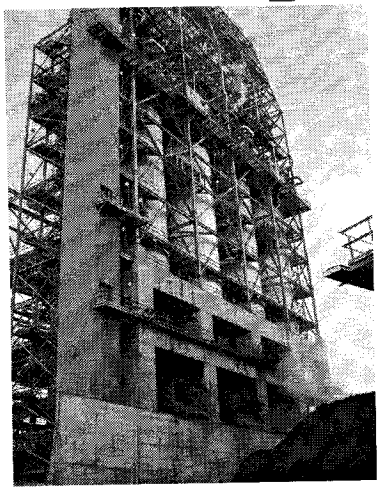


Emergency Egress

Jose Upgrader Protective Shielding
Downview







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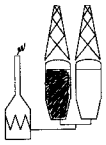


Automated FireWater Deluge System Design

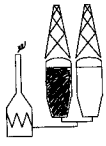
The design can have one or two objectives:

(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

Delayed Coker Safety Benchmarking



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

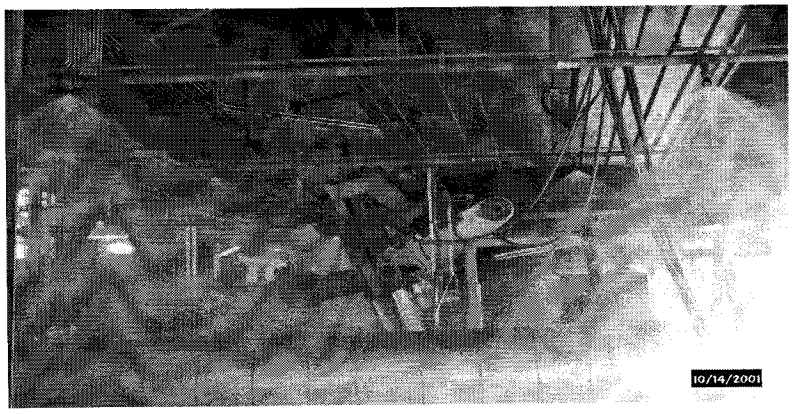
Dedicated Operator during Turnarounds to enforce safety

Battery-powered back-up Lights

Delayed Coker Safety Benchmarking

Automated FireWater Deluge System Design

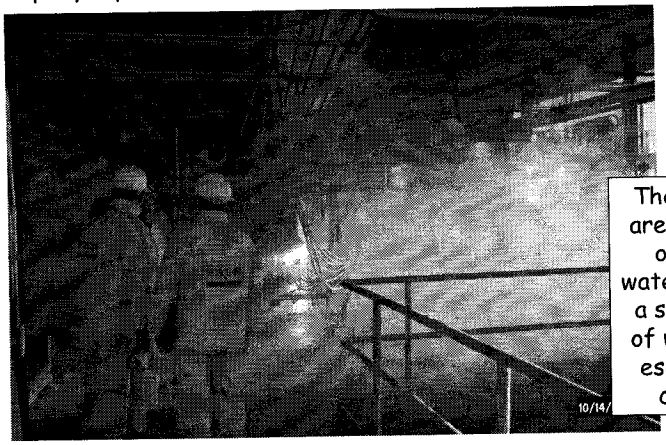
Spray System in Action at ExxonMobil Baytown



Delayed Coker Safety Benchmarking

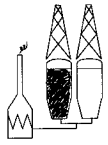
Automated FireWater Deluge System Design

Spray System in Action at ExxonMobil Baytown (view 2)



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

Delayed Coker Safety Benchmarking



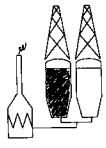
Cutting Shacks

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

Features:

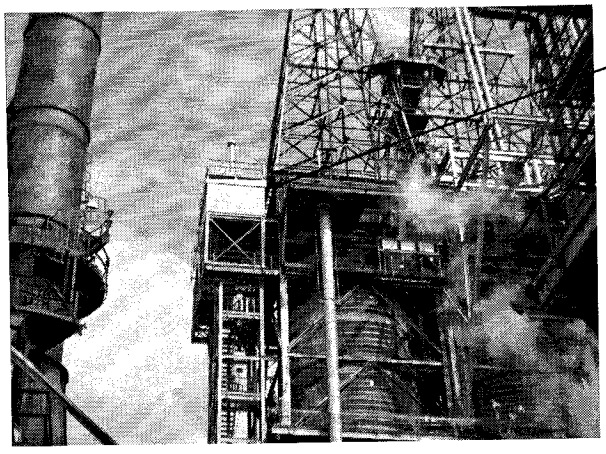
+ Pressurization
+ H2S & HC Alarms
+ Cable winch external to the building
+ Protective Glass
+ Acoustic Coke Cutting Aids
+ Modular Design

Delayed Coker Safety Benchmarking



Modular Cutting Shack Design

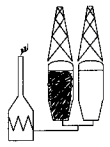
Joliet's Modular Design



Mounted on the side of the top deck, above the stairway.

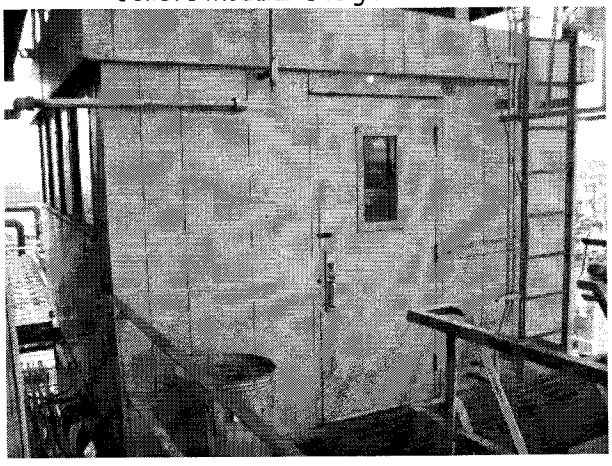
Designed such that it can be relocated to a remote location at grade using a crane lift.

Delayed Coker Safety Benchmarking



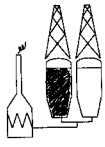
Modular Cutting Shack Design - Up Close

Joliet's Modular Design



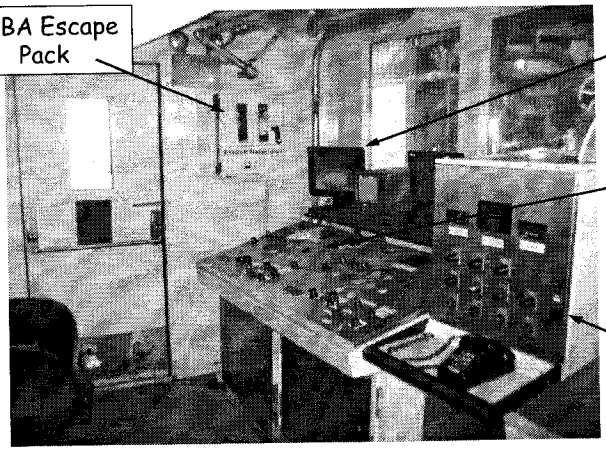
Top deck entrance

Delayed Coker Safety Benchmarking

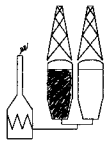


Modular Cutting Shack Design - Inside

Joliet's Modular Design



Delayed Coker Safety Benchmarking



Cutting Shacks

Beaumont's 8-Drum Coker Safety Project

=> Video Camera Survellience

=> Hydraulic Power Unit Panel

=> Automatic Top & Bottom Head Controls & Permissives

=> Water Deluge Panel

=> Jet Water Pump Panel

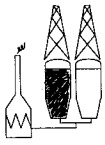
=> Coke Drum Cutting Controls & Monitoring Panels

=> Redundant UPS Systems

=> HVAC, Pressurization, Gas Detectors, Alarms

=> Acoustic Monitoring of Coke Cutting - Patent Pending

Delayed Coker Safety Benchmarking



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

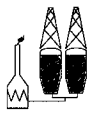
(2) Wait several weeks for the coke drum to cool

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 jumpover to their quench water line (requires special controls!)

=> Other sites are living with the alternatives

Delayed Coker Safety Benchmarking

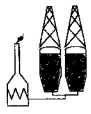


Safe Draining Procedures:

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)

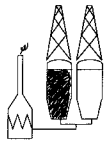
Delayed Coker Safety Benchmarking



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.

Delayed Coker Safety Benchmarking



ConocoPhillips Numeric Facilities Rating

IL's (0 to 8 pts)

- 0 to 7 pts awarded based on percent completion of items found by audit
- 1 - Formal Interlock Audit Completed

Unheading (0 to 7 pts)

- 1 - Remote Top Head opening
- 1 - Top Head Hydraulic lift + Top Eductor
- 5 - Automatic Bottom Slide Valve
- 3 - H&C + Grayloc
- 2 - Grayloc on feed line only
- 0 - Manual Cart on Bottom

Structure Safety (0 to 7 pts)

- 0 to 5 pts awarded based on percent completion of items found by audit
- 1 - Controled Access
- 1 - Formal Safety Egress Audit

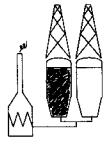
Coke Cutting (0 to 6 pts)

- 3 - Cutting water IL System
- 1 - Free Fall Arrestor
- 1 - Operator in drill cabin
- 1 - Fire & Impact-hardened drill cabin

=> Maximum score is 28

=> Thanks to Bill Burns and Tom Hraban of Conoco-Phillips for permission to present

Delayed Coker Safety Benchmarking



ExxonMobil Numeric Facilities Rating

IL's (0 to 8 pts)

- 8 - Motorized valves with PLC IL's
- +1 - LOTO w/ IOV + Checklist
- +1 - LOTO w/ Independent Operator Verification
- 3 - LOTO
- 0 - Single operator operation

Unheading (0 to 7 pts)

- 2 - Remote & Auto Top Head operation
- 1 - Top Head Hydraulic lift + Vapors Control
- 5 - Automatic Bottom Slide Valve
- 1 - H&C Water Curtain
- 1 - H&C ramp ring
- 1 - Auto Chute / Cover & Grayloc
- 1 - Remote Swing-back Bottom Head
- 0 - Manual Cart on Bottom

Structure Safety (0 to 7 pts)

- 3 - Two stairway fire exits
- 1 - one stand-off stairway or 2 shielded exits
- 1 - Firewater Deluge system
- 1 - Controlled Access
- 1 - Good equip spacing on valve decks

Coke Cutting (0 to 6 pts)

- 2 - Cutting water IL System
- 1 - Redundant drill stem limit switches
- 1 - H2S & HC alarms in shack
- 1 - Pressurized cabin w/ fresh air source
- 1 - Free Fall Arrestor

=> 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