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Improving Coker Safety through better designs and procedures

Tariq Malik, P.E.

CITGO Refining & Chemicals LP

Corpus Christi, TX

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Overview

- Why we have Safety incidents at the Coker ?
- Why Produce Shot Coke ?
- Factors Promoting Shot Coke Production
- Safety Issues with Shot Coke Production
- Coke Drum Switch Safety Interlocks
- Coke Drum Drilling Interlocks
- Bypassing safety Interlocks
- Hot Drums and Bottom Blowouts Containment
- Lesson Learned from recent Safety incidents
- Conclusions

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Why we have safety Incidents at the Coker ?

- Safety Goals- "No one gets hurt". "Zero Incidents"
- Corporate commitment and leadership. Core values
- Expectations, accountability, environment, behavior and follow-through
- Unsafe acts, near misses, injuries, fatalities
- Emergency Preparedness
- Management of Change, especially hazard
- Lack of audits, inspection and preventive maintenance programs
- Contractor safety training issues
- safety incident statistics with equipment out of service, at shift change, at night, unusual operating conditions i.e. startup/shutdown, unit bypassed, post turnaround

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- Unique risk not present in other units
- semi-batch operation
- Failure to follow operating procedures
- Hazardous Energy Control/Isolation, lockout and tagout procedure
- Best engineering practices
- Training needs of individuals versus coaching
- Breakdown in communications
- Unsafe practices and bypassing of safety interlocks
- Use of case histories to learn from incidents elsewhere

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Why Produce Shot Coke

- Allows for maximizing liquid recovery at the vacuum column and improves cut point. Higher overall profitability.
- Most economical form of fuel grade coke. Not desirable for aluminum anodes as anode grade sponge coke.
- Allows for higher feed barrel to the unit. No need to inject slurry, increase recycle, increase system pressure, lower heater temperature.
- Over half of the cokers now produce shot coke

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Factors promoting Shot Coke Production

- Deeper cut point in the Vacuum Column
- Higher S,N and solids in feedstock
- Higher coke drum velocities
- Higher asphaltenes in feed with the ratio C5 insolubles/con carbon approaching 1.0 or C7 insolubles exceed 50% of CCR
- Lower API gravity (<6.0 degree) and higher viscosity of the feed i.e. >1000 cst at 275 F
- Lower drum pressure, lower recycle and higher drum temperature

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Safety Issues with Shot Coke Production

- Uncontrolled dumping of the coke drum content upon unheading (cave-ins). Clean-ups requirements.
- Hot spots in the drum with top blowout/ eruptions, if drum not cooled properly.
- Poor water drainage with plugging of the inlet nozzle.
- Higher density and lower Hardgrove Grindability Index.
- Remote panel operated unheading system and containment of coke cave-ins
- Enclosed cutting station and egress requirements
- Heater Outlet temperature manipulation
- Other Coke Properties

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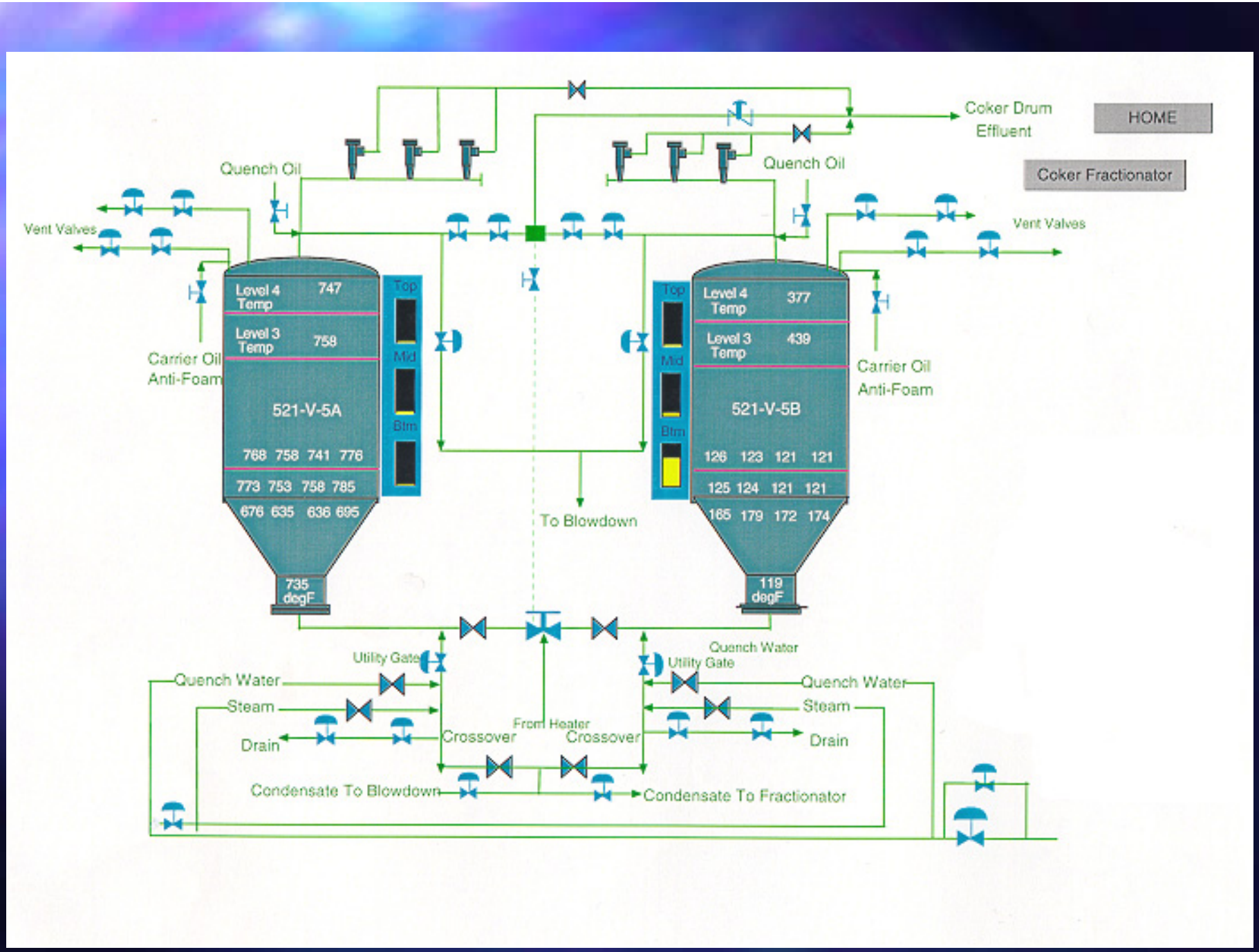
Coke Drum Switch Safety Interlocks

Prevents live drum from being accidentally vented. PLC will only power up the vent valve hand switches, if

- inlet feed valve is closed
- both valves on the drum vapor line to fractionator are closed
- coke drum vapor line valve to blowdown is closed
- coke drum skins are less than 260 F and drum pressure is less than 2.0 psig

Prevents live drum from being accidentally drained:

- coke drum vent valve hand switch has been activated
- all vent MOV are open


Coker Drum
Effluent
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Coker Fractionator
Quench Oil
Quench Oil
Vent Valves
Vent Valves
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Level 3 Temp 759
521-V-5A
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To Blowdown
Utility Gate
Utility Gate
Quench Water
Quench Water
Quench Water
Steam
Steam
Drain
Drain
From Heater
Crossover
Crossover
Condensate To Blowdown
Condensate To Fractionator

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Drum can only be unheaded when:

- vent valve is open and drain valve is activated.

Drum can only be warmed up when:

- PLC will provide control power to the coke drum vapor line valves when the all vent and drain valves have been closed and the drum pressure is above 10 psig . This prevent accidental releasing a hot drum via the offline drum.
- The logic system will not provide control power to the coke drum vapor line to blowdown unless feed line inlet valve is closed. Likewise a drum can only be warmed up with condensate to blowdown drum or fractionator only when feed line inlet valve is closed.

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Coke Drum Drilling Interlocks

The safety system is PLC based which monitors status switches, control solenoids and relays to maintain the operations of the Jet Pump and Coke Cutting Equipment within a safe set of parameters

- Prior to cutting a drum, the Hazardous Energy Control Survey form which is a "permit" to cut a drum is signed off after locks and tags are placed on several valves at the cutting and the switch deck by operations and maintenance crew. At the cutting deck a steam, quench and water valves are locked out. At the switch deck a steam, water, a crossover valve and the inlet feed valve are locked out by the two separate parties.
- Air to Hoist is through a solenoid energized after several condition satisfied i.e. decoking/recirculation valve position in bypass, standpipe

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valve has no pressure and high or low limit switches with the drill stem not activated.

- Before the recirculation valve can open to provide cutting water to the drill bit several conditions must be satisfied, i.e. one standpipe valve must be open and the other closed, the decoking valve must go through the prefill cycle to prevent water hammer with the drill stem inside the drum.
- Likewise, low limit switches and inside the drum limit switches, limits the PLC from taking the decoking valve from the bypass position. Unless the standpipe valve pressure is above 200 psig, the operator cannot switch the decoking valve to the cutting position.
- Additional switches monitor the drill stem position. A high limit indicator will shut off air to the hoist through the PLC.

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Bypassing safety Interlocks

- Bypassing safety interlock for operations or maintenance
- All safety logic bypass keys under control of Supervisors.
- Safety huddle mandatory between shift supervisor, operator, unheading foreman with review of procedure
- No unnecessary personnel allowed in area
- PPE and other equipment requirements
- Sign safety bypass log book
- Verify drum in service, check switch valve position, inlet and outlet wedge plug valves closed, skin temperatures on drum, pressure on drum, vent and drain valve position and blowdown valve position.
- Obtain instrument and electrical assistance for repairs

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Lockout tagout procedures

- OSHA directive 29 CFR 1910.147
- It's the law
- Employers shall safeguard their employees and contract personnel from injury as a result of the unintentional release of hazardous energy by isolating the equipment from energy sources and rendering it inoperative.
- Most cited (enforcement) OSHA regulation
- Improper use of Lockout/Tagout devices and incomplete information on tags
- A positive means of identifying and verifying all hazardous energy isolation and control points is through the HEC survey/Blind list.

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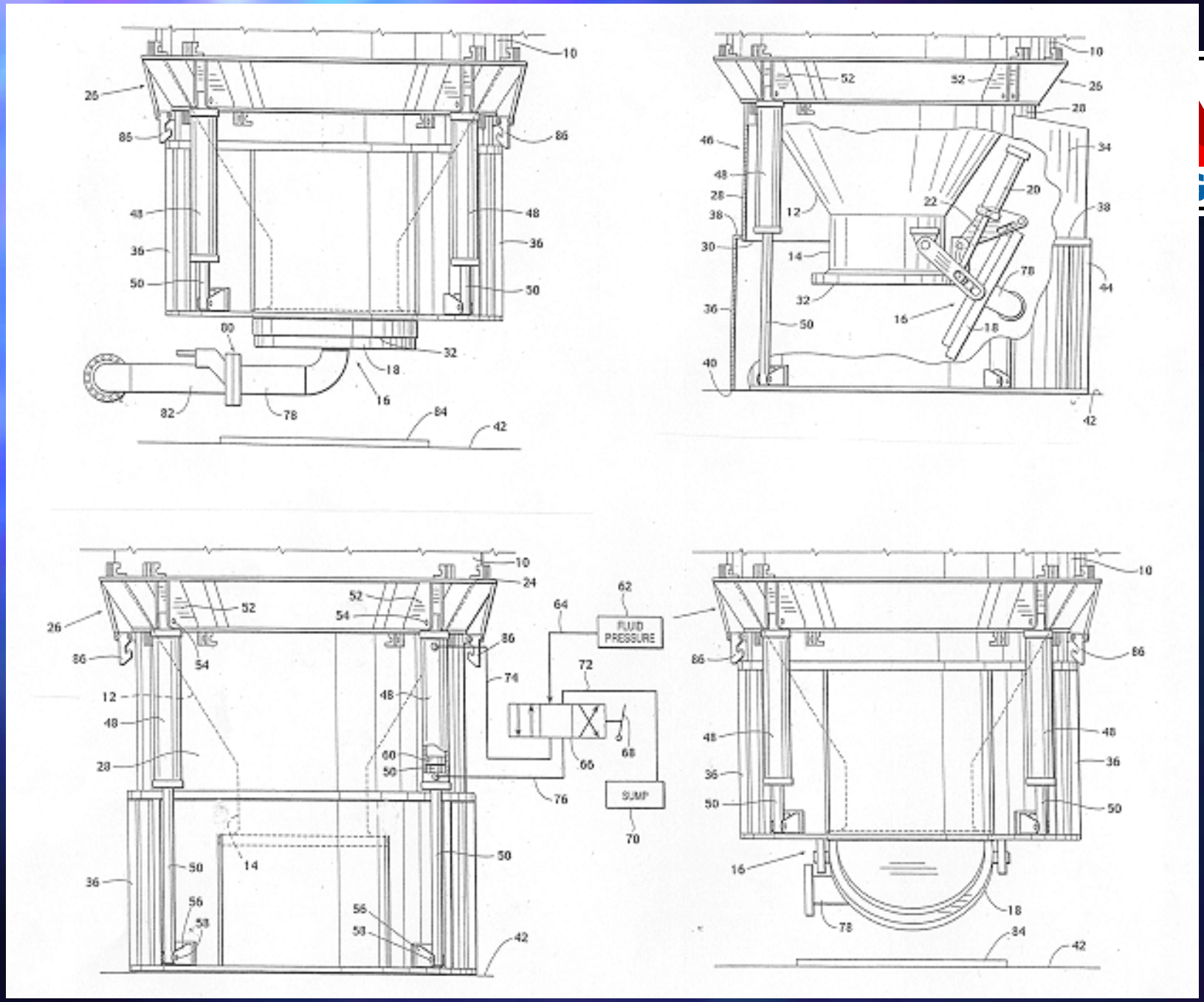
Hot Drums and Bottom Blowout Containment

- Causes for hot drum
- Impact of shorter cycles
- Understanding SARA analysis as a blowout predictor
- Bottom cave-ins while unheading
- Top blowout during cutting
- Impact of bottom head inlet distributor
- Impact of pumping sludge to the coke drum
- Remote unheading of coke drums
- Designs to contain bottom blowouts
- Protecting operating personnel on the switch/cutting deck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FLUID PRESSURE
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Lesson Learned from recent Safety incidents

- 16 refinery workers killed in Coker unit fires between 1992-2000
- Pressure testing coke drum with Graylok flange not properly made up, October 16, 2000, one employee and two contractor injured
- Flash fire on off-line drum top head swivel pin repair, October 1999, one killed and one burned. Fuel source was hydrocarbons from bottom of fractionator.
- Fire on Coker drilling deck, May 7, 1999, one burned. Isolation by one motor operated valve not powered down. MOV switch was bumped releasing vapor from the live drum.
- Drill stem operating outside the drum, May 2000, one killed
- Inadequate quenching of coke drum, November 25, 1998, six killed. Power failure triggered events. Cloud upon bottom head removal ignited with rapid expulsion of tar from drum.

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- Live drum unheaded, summer 1997, one killed
- Coke drum bottom head auto unheading operation, two separate incidents, July 1995 and October 1998, two injured
- Front-end operator at the coke pad while drum being cut, 1999, one injured
- Live drum drain line opened up to coke pad, summer 1998, fire with no injury. Dead man switch wiring required on all structure actuators. Need to power down motor operated valve which can cause accidental release of hazardous material.
- Carbon steel mitre joint in 5 Cr. heater discharge line split open with three fatalities on switch deck, August 3, 1993. Deluge system inadequate and egress system reengineered.

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Conclusions

- Through improved design, engineering best practices, procedures and training, Coker units producing shot coke can be made even more safer
- Industry needs to perform several repetitive steps remotely and keep workers out of harm way
- Industry should give recognition to companies and individual working to make Cokers a safe place to work in