Opening Process Equipment Important Considerations

REFCOMM BUDAPEST 2017

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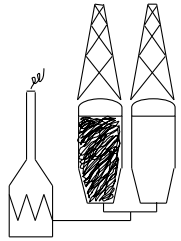

Topics:

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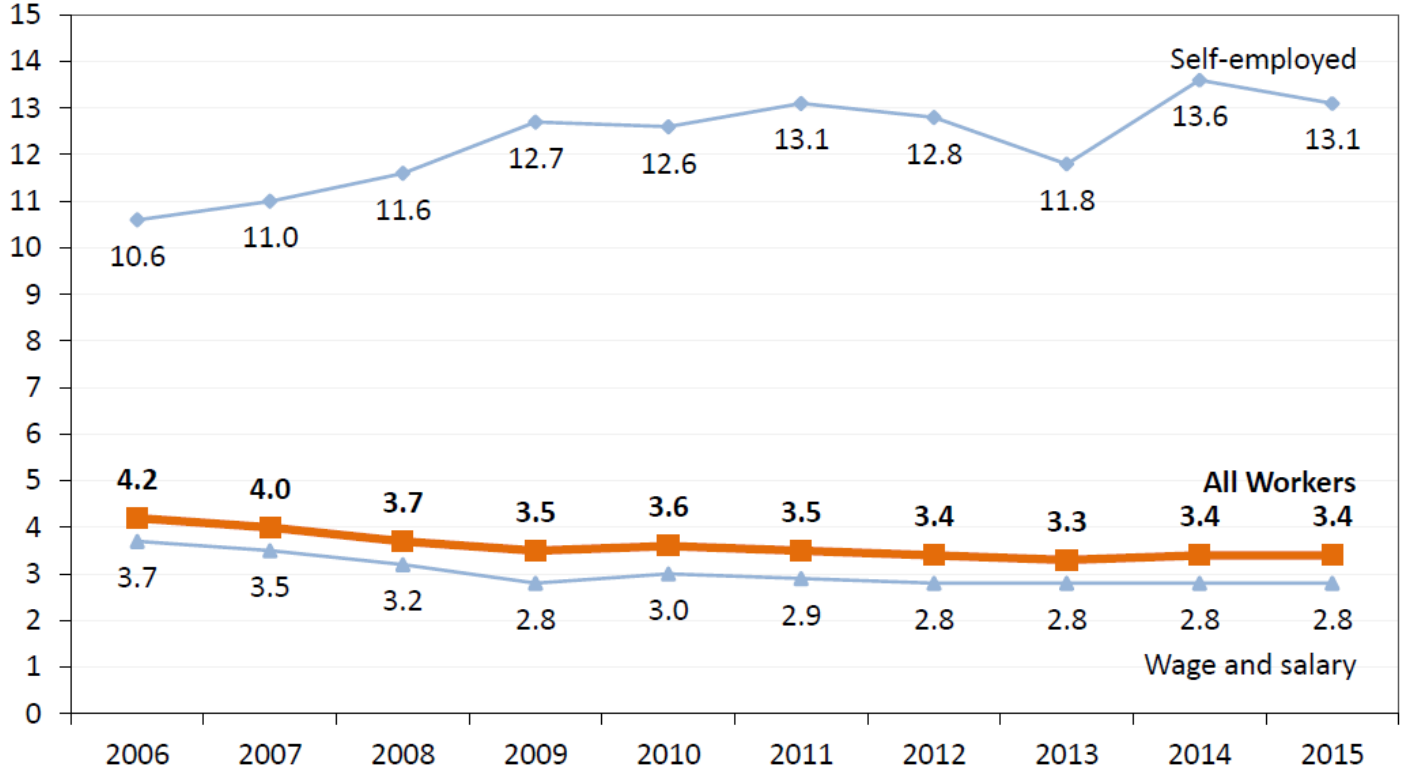
U.S. Bureau of Labor Statistics – Fatal Work Injuries in 2015

4,836 fatal US work injuries recorded in 2015, a slight increase from 4,821 in 2014
=> the highest since 5,214 fatal injuries in 2008 (~ 142 million workers)

The overall rate of fatal work injury for workers in 2015, at 3.4 per 100,000 full-time equivalent (FTE) workers, was the same as 2014. In 2001, the rate was 4.3.



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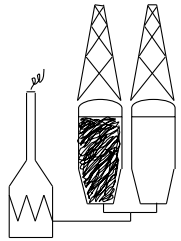

Frequency of US Fatalies per 100,000 people – On Average

Average Occupational Fatality Rate = 3.4

Hit by Lightning	0.01
Die from Carbon Monoxide	0.05
Manufacturing Sector	2.9
Pedestrian	3.0
Hunting	9.0
Contract Employee	10.0
Driving an Auto	10.9
Construction	12.5
Oil & Gas Extraction	13.1
Farming, Fishing, Forestry	22.8
Truck Driver	24.5
Offshore Platform	~25
Death by Firearm (Guns)	~30

Age	
19 – 20 years old	2.1
>65 years old	9.4

Gender	
Men	5.5
Women	0.6

Location	
NY, NJ, California	2.1
Wyoming & N Dakota	~12

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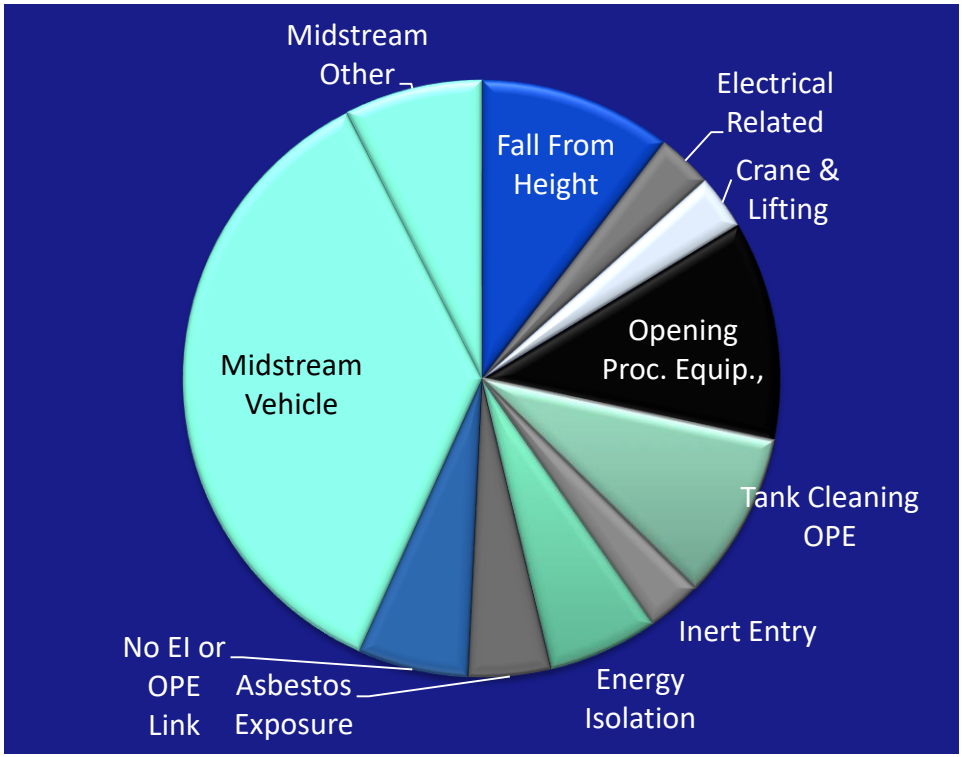
Example of Corporate Refining and Chemical Fatalities 2000 to 2014



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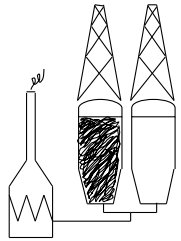

Events – Energy Isolation Fatalities

(1) A piping erection subcontractor was on the top level of the offsite pipe rack. A long 24" diameter spool piece rolled off its supports while being positioned, crushing the welder between the pipe and the scaffold walkway he was standing on. (may-2000)

(2) Fatality of a contractor due to a collapse of a part of the floating roof of a crude oil tank (jun-2000)

(3) Chemicals Contractor was pinned within a robotic mill roll carriage. The contractor was dismantling the carriage drive shaft, while another contractor was removing the mill roll lift brake motor. Following motor removal, the mill roll frame fell, pinning the contractor handling the drive shaft. (aug-2000)

(4) A four-man metals crew was working to cut up sections of scrap pipe from a nearby tank demo job. While attempting to cut a 25-ft section of 12" pipe into two pieces, the piping moved in an unanticipated way and direction - contacting a worker in his chest and resulting in a fatality. No injuries to others. (mar 2008)

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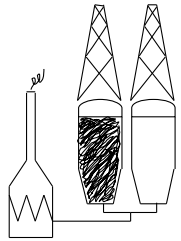

Events - OPE

(5) 1 Employee Fatality & 3 employee injuries occurred as a result of a fire at the gas oil hydrofiner (apr-2003)

(6) 6 Tank Cleaning Contractors were fatally injured during a fire while cleaning a gasoline tank. This was in association with a project to replace floating roofs. (aug-2003)

(7) Technician, on special assignment for a Chemicals TA, was injured as a result of a fire while changing a filter at a solvents unit. He suffered burns to 60 - 80% of his body and died 36 days later. (aug-2003)

(8) 3 fatalities, 1 injury - A fire broke out during de-blinding work on the crude unit overhead exchanger. Response teams came immediately. The fire was extinguished within an hour. (may-2007)

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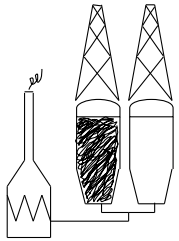

Events – OPE (cont'd)

(9) Fatality - Release of hot condensate and steam from coke drum bottom head. The employee was treated on site for burns and transported to an off site medical facility. (apr 2009)

(10) A fire occurred on a Diesel Hydrotreater when contractors were preparing a feed-product heat exchanger for bundle removal. The incident resulted in 12 injuries (2 Fatalities and 5 lost-time) (apr 2013)

Events – Confined Space Entry

(12) Inert Entry 1 Fatality, 1 lost-time injury while performing work under inert conditions inside Pressure Swing Absorber vessels during TA. (mar 2011)

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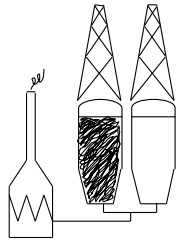

Basis

- Electrical Safety Work Practices and associated energy isolation has its own Best Practice document
- Establish Hazard Classes (following slides)
- Exemptions from strict compliance (though safe procedure must be in place):
  - ✓ Low hazard class materials small bore piping
  - ✓ Insertion and retraction of analyzer probes
  - ✓ Opening environmental test ports on furnace stacks
  - ✓ Atmospheric Tank Vapor Space PV-vents and instruments
- Proper Tag Protocols (following slides)
- Certain process activities require documentation of “Clarifications and Approved Deviations” Two Examples:
  - ✓ Cooling Tower Entry for maintenance
  - ✓ Delayed Coker – Coke Drum Cyclic Operations

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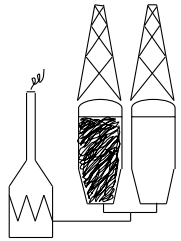

Hazard Classes and Categories - Examples

- Create a matrix of Matieral Hazard Classes and Key Categories; e.g., Toxicity, Flammability, Reactivity and Corrosivity

Classify Hazard Risk Level based on Material Type

- Class-1 - Dangerous or Acutely Fatal
  - ✓ Above auto-ignition temperature; hydrofluoric acid, etc.
- Class-2 - Hazardous
  - ✓ Pressurized gases; flammable liquid; combustible liquids near flash point; pyrophorics; acids; caustics
- Class-3 - Potentially Hazardous
  - ✓ Combustible liquids more than 8°C (15°F) below flash point; irritating chemicals
- Class-4 - Innocuous
  - ✓ Non-Combustible liquid; not reactive with air/water; non-flammable; non-corrosive (e.g., steam and water)

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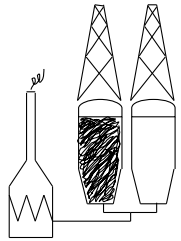

Hazard Classes and Categories – Examples (cont'd)

- Create a matrix of Hazard Classes based on Physical Properties; e.g., Pressure, Liquid Temperature, Vapor Temperature

Classify Hazard Risk Level based on Physical Properties

- Class-1 > 69 barg (1000 psig); Liquid temperature > 260°C (500°F); Vapor Temperature > 425°C (800°F)
- Class-2 14 to 69 barg (200 to 1000 psig); Liquid temperature 93 - 260°C (200 - 500°F); Vapor Temperature 205 - 425°C (400 - 800°F)
- Class-3 3 to 14 barg (50 to 200 psig); Liquid temperature 60 - 93°C (140 - 200°F); Vapor Temperature 60 - 205°C (140 - 400°F)
- Class-4 < 3 barg (50 psig); Liquid temperature ambient to 60°C (140°F); Vapor Temperature 60°C (140°F)

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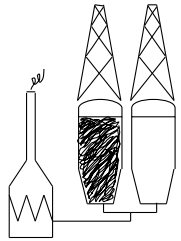

Tags and Labels

- Visual cues and job aids to help control work in accordance with plans/permits and are required to help prevent human errors.
- Minimum Requirements:
  - ✓ Standardized Design unique to Energy Isolation Control (EIC) and OPE
  - ✓ Site shall audit for proper use
  - ✓ Weather resistant, durable and properly fastened
  - ✓ Tags must be traceable to EIC documents and responsible personnel
- Energy Isolation Device Tag (typically a valve)
  - ✓ Example - “Warning – Energy Isolation Device – Do Not Operate”
  - ✓ Proper Labeling designating owner of securing device

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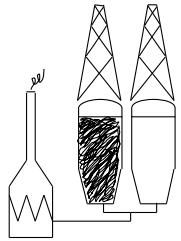

Tags and Labels (cont'd)

- OPE Location Tag
  - ✓ Prevents opening wrong equipment or piping
  - ✓ Attached to the flange, man-way or cover plate to be opened or affixed to the physical location of non-bolted openings
  - ✓ For pipe cuts, the cut location needs to be marked on the pipe itself in conjunction with OPE tag as specified in site procedures
  - ✓ Example - "Opening Location" with unique number for cross referencing to procedure
- Energy Verification Point (EVP) Tag
  - ✓ An EVP tag shall be applied at the bleeder valve of a double block and bleed assembly.
  - ✓ Applied to the location(s) on the equipment where hazardous energy and material exposure is tested to verify whether the equipment has been de-energized (electrical energy) or depressurized and drained to the extent the equipment and piping configuration allow, and any valve in the energy verification pathway.
  - ✓ Example – "Energy Verification Point"
  - ✓ Should Indicate whether it is a valve in the pathway to EVP bleeders or the EVP bleeder itself.

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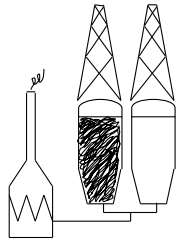

Guide Requirements

- Site must establish a Structure that applies the Recommended Guidelines for Establishing "Critical Life Safety Measures" (CLSM's)
  - ✓ Must define the needed Layers of Protection (LoP) and procedures to ensure that all sites consistently and effectively perform "Energy Isolation", OPE and Confined Space Entry (CSE)

Sites must have a PLAN for the following:

- Control of Exposures Associated with Hazardous Energy and Materials
- Isolate, Clear and Secure the Energy Isolation Envelope from Energy Sources that are, or May Become, Connected to the Equipment Being Worked on
- Transition to and Execute the Mechanical Phase of the Work
- Re-instate Equipment Integrity to Allow Equipment Return to Service

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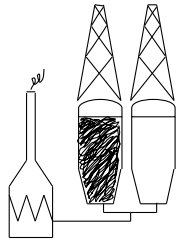

Control of Exposures Associated with Hazardous Energy and Materials

- Sites have the fundamental management system structure and processes in place
- Job Plan(s) are prepared before work commences

Isolate, Clear and Secure the Energy Isolation Envelope from Energy Sources that are, or May Become, Connected to the Equipment Being Worked on

- Isolation Plans are independently confirmed, opening locations are identified and activities are performed to establish the Energy Isolation Envelope.
- Equipment is Drained, Depressured, Energy is Discharged and Equipment is Cleaned of Material Hazards to the Extent that Equipment Configuration Allows
- The Energy Isolation Envelope is secured for the duration of the job(s).
- Isolation Plan Execution and Effectiveness is independently confirmed in the field

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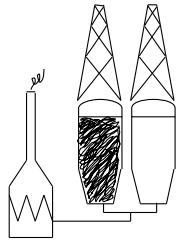

Transition to and Execute the Mechanical Phase of the Work

- Safe work conditions are confirmed at job-time and communicated to affected personnel
- During equipment opening, release of residual material is controlled / mitigated
- Safeguards are in place for potentially exposed personnel during the work
- Equipment is Drained, Depressured, Energy is Discharged and Equipment is Cleaned of Material Hazards to the Extent that Equipment Configuration Allows
- Personal Protective Equipment (PPE) and Defensive Behaviors are used to safeguard personnel

Re-instate Equipment Integrity to Allow Equipment Return to Service

- Visual checks and actions to ensure integrity of the job pressure boundary are performed before energy and/or process material is re-introduced
- An Operational Leak Test and/or in-service test is performed before returning equipment to service

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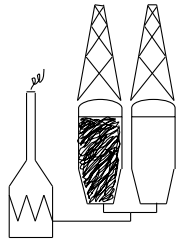

Circuit Isolation

- Circuit Isolation is a blinded or disconnected group of contiguous equipment and piping systems
- Sites shall have a process to assess whether circuit or individual equipment isolation is the best option for the job.
  - ✓ Circuit shall be disconnected or blinded, drained and purged/cleaned of process fluids
  - ✓ All blinds/disconnect points defining the energy isolation envelope for the work shall be installed and equipment/piping systems prepared per job plan.
  - ✓ A safe energy state in the equipment/piping within the energy isolation envelope shall be verified and maintained throughout the work.
  - ✓ Other energy sources (for example, spring, gravitational or radioactive) shall be isolated.
  - ✓ The removal of any Circuit Isolation blind or reconnection of a disconnection point and reinstating equipment integrity for return to service shall comply.

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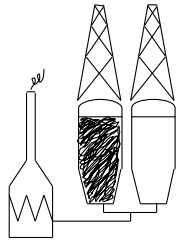

EQUIPMENT OWNER LIMITED SCOPE WORK

Does not require a new "Plan" every time it is executed, but does require a documented procedure/work-plan that meets all safe practices

- Consists of tasks involving 3 or less process Energy Isolation Devices (EIDs) in the immediate control of the worker, or up to 5 process EID(s) when the 4th and 5th process EIDs are part of a connected purge system (for example, nitrogen/flare) and also within the immediate control of the worker.
- One non-process EID controlling hazardous energy may also be involved, which shall be secured, if not in immediate control of the worker (e.g., electrical).

Limited to the following activities:

- ✓ Routine mechanical activities performed by Operators (for example, cleaning strainers or filters, changing steam traps, unplugging small bore piping).
- ✓ Maintenance of analyzer systems and tubing or piping connected instrumentation (for example, Analyzer Technician performing preventive maintenance on an isolated process analyzer).
- ✓ Maintenance of chemical injection skids, and similar equipment, after isolation from process equipment.

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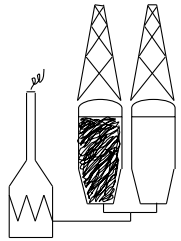

Energy Isolation – Key Points

1) Means to isolate energy and process material and identification of isolation device locations

All personnel associated with work are dependent on the integrity of the energy isolation envelope. Making the envelope as small as possible (using the closest EIDs to the work):

- Minimizes the exposure to trapped material.
- Reduces the potential for stagnant equipment zones.
- Reduces potential for inadvertent connections within the envelope (especially important for confined space entry).
- Reduces the volume of exposure that could occur if material is released.

2) Energy Verification Points to be used

- ✓ Verification points are used to prove the effectiveness of the energy isolation.
- ✓ Residual material can be trapped between the work location and the EVP.
- ✓ Safe energy state must be verified on both sides of each individual blind installation location.

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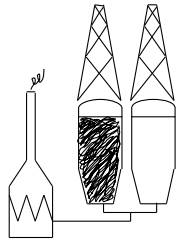
Energy Isolation – Key Points (cont'd)



3) Blind removal

The removal of blinds requires verification points on both sides of the blind. A "trapped space" will be present on a side of the blind without a bleeder to use for energy verification.

4) Potential for injury - exposure to stored, improperly isolated, or residual energy

Personnel may be injured by stored, improperly isolated or residual energy if not provided with appropriate Personal Protective Equipment (PPE).

5) Work on or in the Hazard Zone of open-ended process equipment. For example, work at the end of an open-ended pipe, flare tip or furnace stack

Hazardous energy or material may be released from the open end of the equipment/piping, injuring personnel working in the area

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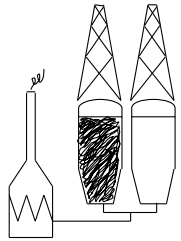

OPE – Key Points

1) Know Equipment's Previous Contents and History

- ➢ Fire triangle
- ➢ Pyrophorics
- ➢ Scale, sludge, catalyst
- ➢ Materials that change phase based on pressure or temperature

2) Conditions behind isolation valves including temperature, pressure

- ✓ Phase changes and loss of seal
- ✓ Ignition / leakage concerns

3) Equipment Configuration

- ✓ Understand risks with draining, energy verification, and residual material control

4) Size and type of equipment opening(s) required: Diameter, Flange, Irreversible openings (cuts, exchanger heads)

- ✓ Understand hazards

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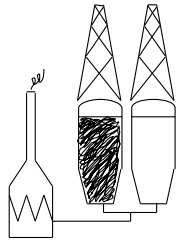

OPE – Key Points (cont'd)

5) Equipment Support – Prior to and After opening (Mechanical Plan)

- ➢ Threaded connection damage risk during opening
- ➢ Piping Stress at opening location may cause movement
- ➢ Covers on vessels and heat exchangers can move

6) Method for depressuring the equipment (bleeder(s))

- ✓ Process material release

7) Method for Draining

- ✓ Volume risk
- ✓ Stagnant zones, dead legs, low points, blocked paths
- ✓ Risk of hoses to open containers – splashing and static charges
- ✓ Light ends draining => brittle fracture and freezing of water

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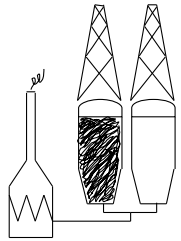
OPE – Key Points (cont'd)



8) Cleaning hazardous materials from equipment prior to opening

- ➢ Removing residual material – foulant and phase-change

9) Potential for the release of residual material requiring capture

- ✓ Ease of flushing; heat exchangers can be challenging
- ✓ Temporary facilities considerations - spilling, splashing and ignition

10) Positive identification of the equipment opening location and traceability to other job documentation

- ✓ Avoid opening at wrong location

11) Type of PPE and RPE (Respiratory Protective Equip)

12) Establishment and Maintenance of Exclusion Zones

- ✓ Ensures the work area is not entered during opening by personnel and equipment not required at the jobsite.

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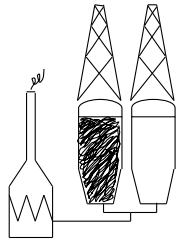
OPE – Key Points (cont'd)



13) Job stoppage requirements

- ➢ Work crew awareness relative to potential risks and how to evacuate

14) Egress and Evacuation Routes Defined

15) Supervision or Safety Watch for Hazardous Tasks

16) Additional Gas Testing

- ✓ A negative result does not mean there is no risk, but a positive result means extra measures and precaution are needed
- ✓ Situation dependent

17) Operational Leak Test prior to Restart

18) Control use of Temporary Enclosed Spaces at Equipment or Piping Openings

- ✓ Avoid accumulation of asphyxiants or toxics

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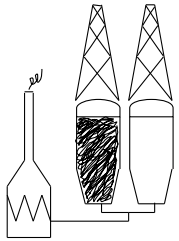
Delayed Coker EI and OPE Considerations



=> Batch Operation and Older Designs create Challenges

- Isolation Execution (IE) can begin during the Coke Drum Drain Step.
  - There is a fundamental difference between Delayed Cokers that handover the coke drum to a contractor, who then performs the deheading-cutting-reheading tasks, versus those who perform deheading-cutting-reheading with the same personnel that perform the structure valve operations.
  - If a contractor is involved, it is recommended that IE begin once drain is completed, and that it involve both the company field representative and the contractor field representative.
  - If no contractor is involved, IE can start during coke drum draining, but will still involve two people to verify IE, the coke drum field technician and the coke cutter.
- Energy Verification Points (EVP's) that correspond to the Coke Drum IE are the vent valves and drain valves
- Top unheading device and bottom unheading device on each coke drum will be designated as permanent coke drum "Opening Locations"

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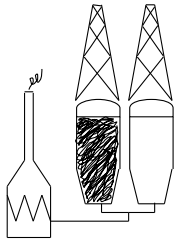
Delayed Coker EI and OPE (cont'd)



- "Barrier Steam" or "Sweep Steam" is used between many of the double block valve arrangements

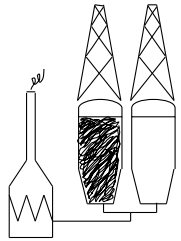
  Pressure in the piping spool can range from 5 to 150 psig (0.3 to 10 barg)

  There are two established methods for setting barrier steam:

  1) Pressurize the piping spool between the valves with steam with the drain closed, floating on the steam grid. This creates a barrier, such that steam either leaks through the switch valve into the coking drum or leaks through the block valve to atmosphere.
  2) Establish steam flow through the spool out the drain line, which connects to the coker blowdown system; pressure either floats on the BD system or is throttled to hold an intermediate spool pressure for proper valve seating (if needed). Leakage through the switch valve enters the spool and flows to a closed system. Should the block valve leak, steam and possibly hydrocarbon will leak to atmosphere. In both cases positive verification that the steam is set correctly is needed – this can be via a change in spool pressure or temperature. This must be done as part of IE.

- Shut-off of power to Motor-Operated Valves (MOV's) must be verified.
  - The recommended procedure is to install an LED indicator light in the circuit, that turns off when de-energized.

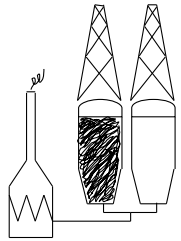
Opening Process Equipment Delayed Coker EI and OPE (cont'd)



- In regard to cyclic valve operations, permanently engraved locks, etched with a specific valve identifier or metal tag, etched with a specific valve Identifier, will be used as Securement Devices for positive lock-out of all designated manual and motor-operated valves
- MOV's are designed with the option of manual operation, should the electric motor fail. A declutch lever disengages the motor actuator and allows use of a hand-wheel to change valve position.
  - Some cokers permanently remove the hand-wheel, allowing use of a pneumatic power-wrench to operate the valve.
  - Securement of the declutch lever and/or hand-wheel is required using a unique approved securement device(s) as per site Coker LOTO/Securement standards.
  - Securement Devices must meet the 50-pound breaking strength
  - Some MOV's maintain valve position indication during manual operation and some do not. Additional manual verification is needed, if position indication is lost.
- At the end of IE, a Check-off List must be completed and signed by two people.
  - This involves verification that all required valves are in their correct positions, de-energized and properly locked out; and that all steam spools between double block isolation valves are properly set.

Opening Process Equipment

Delayed Coker EI and OPE (cont'd)



- Each coker must define their Exclusion Zones while venting & draining, unheading, and decoking
  - A document should be created that sets restrictions on when non-essential personnel are allowed on the coke drum structure
  - In regard to safe coke drum draining following coke bed water quenching, the Energy Verification Method must be done using at least two, and preferably three methods.
  - Coke, water and steam releases from the bottom of the coke drum are controlled via use of "remote unheading devices and procedures," which reduce the probability of injuries to a very lowprobability.
- Coke Pit / Pad is an exclusion zone

Procedures control access to the area during draining, unheading and coke cutting. Personnel must not be allowed within a site-determined distance from the containment walls and drain discharges.

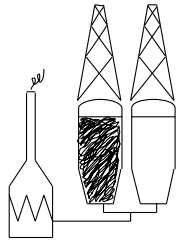
Gantry crane and Front End Loader operations must also be controlled.

Should the PIT/PAD be FULL of coke, creating the risk that coke being cut from the drum could "deflect" out of the containment area, additional precautions and restrictions are required.

Should steam emanation obscure visibility in the PIT/PAD, then apply additional precautions.

Opening Process Equipment

OPE – Special Conditions



1) Isolation *Not* at Nearest point for OPE work

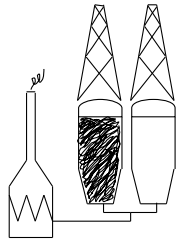
RISKS:

- To minimize the volume of material potentially trapped within the isolation envelope.
- To prevent introduction of new hazards by minimizing connections to the equipment being worked on. (Personnel not involved directly with the work may inadvertently hook a hose to a bleeder or in some other way compromise the integrity of the isolation envelope).

ACCEPTABLE ALTERNATIVE

- ✓ Movement of the isolation location for a logical safety reason. (For example, to capture a bleeder for cleaning).

Opening Process Equipment



OPE – Special Conditions

2) Irreversible opening (saw cutting, tapping, exchanger bundle pulling)

RISKS:

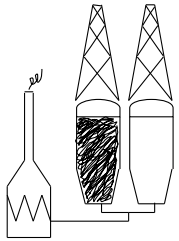
- Equipment integrity cannot be immediately restored.
- No means to control the release of residual material during the opening. (Re-closing the equipment break is not possible in these situations).

MITIGATIONS:

- ✓ Check for residual material at the best Energy Verification Point (EVP), if available.
- ✓ For saw cut openings, include drilling a pilot hole, if no EVP is available.
- ✓ Require provision for adequate containment of potentially spilled material.
- ✓ Include requirement for OPE Standby during irreversible openings on all piping openings and on exchangers where Hazard Class 1, 2 or 3 liquids may be present. For multiple openings on same line (e.g., line demolition) consult with the Owner to determine which openings require Standby attendance based on potential for residual material and proximity to hazardous live lines. OPE Standby attendance is required from the time the seal could be broken until a safe hazard state has been achieved.
- ✓ Contingency plan if more than the anticipated volume of material is released.
- ✓ Provide at least one unimpeded escape path from each worker position if Hazardous Material is potentially contained.

Opening Process Equipment

OPE – Special Conditions (cont'd)



3) No representative Energy Verification Point (EVP) available for an opening location (including trapped blinds)

RISK:

- Equipment depressuring and draining cannot be verified. An unknown quantity of hazardous process material may be trapped and released during the opening.

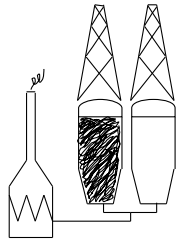
MITIGATIONS:

- ✓ Use the site procedure that describes the safest method possible for draining and depressuring that equipment.
- ✓ Consider the use of a vented blind or an alternate isolation location that incorporates an EVP that uses the site process/procedure/tool (such as a decision tree) for evaluating blind locations based on ability to verify energy state.
- ✓ Document the potential exposure to trapped volume. Specify containment that will be adequate for the potentially trapped volume and drainage to a safe location at grade. Consider associated jobsite hazards.
- ✓ Require PPE based on the material that will be present at the opening.
- ✓ Develop Contingency Plan and require OPE Standby for Hazardous Materials.

ACCEPTABLE ALTERNATIVE: Hot or cold tapping a bleeder to drain and verify energy in equipment/piping as per site procedures.

Opening Process Equipment

OPE – Special Conditions (cont'd)



4) OPE at elevation of greater than 2 meters (6 feet) above grade

RISKS:

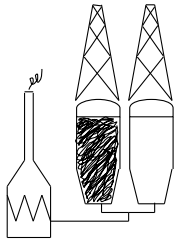
- Elevated work typically results in reduced number and size of egress path, and a smaller work area. This results increased potential for exposure to released materials.
- Residual liquids can cause fire below the work area..

MITIGATIONS:

- ✓ Provide an adequately sized work platform
- ✓ Provide at least one unimpeded escape path from each worker position if Hazardous Materials are involved
- ✓ Arrange the work area such that personal fall protection is not required. If the work area cannot be modified to eliminate the need for personal fall protection, the fall protection shall allow immediate safe egress away from the opening location.
- ✓ Provide grounded/bonded containment with provisions for safe, timely liquid removal to grade.

Opening Process Equipment

OPE – Special Conditions (cont'd)



5) Ignition source is present or will be brought in for work within 10 meters (33 feet) of OPE location, except for verified non-Hazardous Material

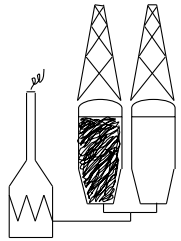
RISKS:

- Near-by ignition sources may ignite flammable vapors released from the opening.
- All Ignition source hazards must be controlled during blinding, deblinding and equipment removal operations. Material can be spilled from equipment openings during removal, even with blinds in place on the pipe openings.

MITIGATIONS:

- ✓ Where fixed ignition sources are in operation, or where diesel or other portable powered equipment, are used for removal of bundles in Hazardous Material service, the following shall be provided:
  - Ensure the cleanliness threshold is defined for the flow path
  - Specify continuous gas monitoring
  - Specify the criteria for the OPE Standby to monitor the work area and initiate ignition source/engine shut down and evacuation on detection of flammable vapors and gases
  - Consider the need for additional fire protection (for example, charged fire hose)
- ✓ Require blind/blank isolation and gas testing per site procedures prior to continuation of work on opened equipment with ignition sources present.

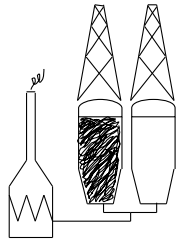
Opening Process Equipment



Additional Information

Opening Process Equipment

OPE – Special Conditions (cont'd)



6) Potential for liquid accumulation between a blinding location and its verification point in vertical piping. Except for verified Hazard Class 4 material service.

7) Opening made on equipment under positive pressure or vacuum

8) Draining Hazardous Material to an open system, or flammable material at elevation using an open system to drain to grade

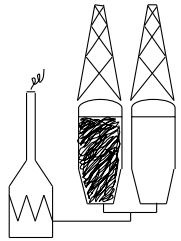
9) Block valve known or expected to leak through in Hazardous Material service

10) Equipment supported by a mobile crane or rigging device

11) Equipment under stress conditions that may result in pipe movement with potential to impact work crew

12) Equipment previously containing Very Hazardous Material, that cannot be flushed or cleaned with low-Hazard Material

Opening Process Equipment



OPE – Special Conditions (cont'd)

13) Situations where PPE is used:

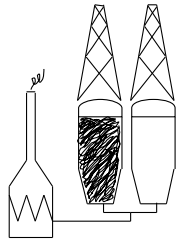
- As the only layer of protection against hazardous energy exposure and for which no approved site procedure exists for energy isolation activities.
- Instead of positive isolation or provision of energy verification during opening process equipment work.
- Where appropriate engineering or administrative hazard controls for confined space work are unavailable.

MITIGATIONS:

- Use of new or existing high quality & inspected PPE suitable for work performed
- Contingency planning, including provision for decontamination and rescue as required
- Require Arc flash protection or other PPE for electrical energy
- Note: All Special Conditions and Deviations that result in the use of PPE, as the only LoP for OPE and CSE work must be analyzed and authorized

Opening Process Equipment

OPE – Special Conditions (cont'd)

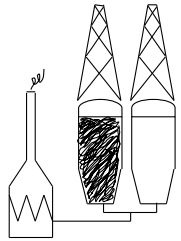


14) Equipment containing material with Hazard Class 1 physical properties behind single isolation valve(s)
    - Use site procedure(s) for safely opening EVP bleeder and equipment
    - Consider use of RPE, if hot vapors could be inhaled during the operation.

15) Inability to clean and verify parallel flow paths individually
    - Include requirement to clean all flow paths, with verification of cleanliness threshold for each flow path, if arrangement allows.
    - Where equipment arrangement does not allow for cleaning through individual flow paths, the plan shall take into account the residual material in flow paths that cannot be confirmed as being cleaned.

Opening Process Equipment

OPE – Special Conditions (cont'd)



16) Operational Leak Test requiring the use of Hazard Class 2 or 3 Material

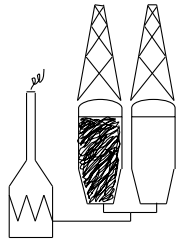
RISK - Release of Hazardous Material can occur during the test

MITIGATIONS

- ✓ Require documented confirmation that all bleeders are closed and plugged.
- ✓ Require personnel exclusion zone and control of ignition sources as per OPE requirements relative to all potential leak points.
- ✓ Specific the use of toxic/flammable gas detectors as appropriate for the test fluid to identify leaks.
- ✓ Include slow ramp up of pressure with initial low pressure check for leaks..

Opening Process Equipment

OPE – Special Conditions (cont'd)



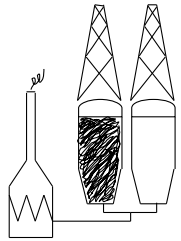
17) Single block valves in dirty, fouling and phase change service

RISK - Dirty, fouling and phase change service may compromise the sealing capability of valves, flanges, and threaded connections. Dirt and scale can migrate during cleaning, making re-seating of valves and isolation difficult or impossible.

MITIGATIONS

- ✓ Identify the next available upstream block valve.
- ✓ Develop a contingency plan to document the action to be taken if/when leak through is detected on envelope block valve.
- ✓ Include a warning in the plan to not manipulate the isolation valve(s) in this service while the equipment is open. The equipment opening must be closed before attempting to further close the valve.
- ✓ When the upstream block valve is remotely located provide a Standby person to close the valve as required in the contingency plan.

Opening Process Equipment



Confined Space Entry – Key Points

1) Define and Maintain Exclusion Zones

2) Job stoppage requirements
   - ➢ Work crew awareness relative to potential risks and how to evacuate

3) Egress and Evacuation Routes Defined

4) Pyrophorics or Flammables trapped behind scale or linings

5) Supervision or Safety Watch (in addition to required “hole watch” or air supply monitoring person

6) Residual material risks generating flammable or toxic vapors

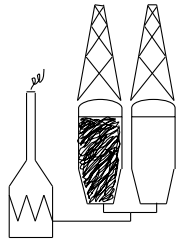
7) PPE and RPE to be defined

8) Proper Ventilation

9) Working with residual liquid or solid material
   - ✓ Free-flowing liquid, catalyst, sand or other solid material can engulf personnel in the confined space

Opening Process Equipment

Confined Space Entry – Key Points (cont'd)



10) Fall and Cutting Hazards

Fall hazards:

- Damaged lining or deposits on vessel ceiling or walls.
- Hoisting or transportation above personnel in the space.
- Height differences in vessels or damaged internals.
- Hazards related to personnel working below filled catalyst loading socks or similar equipment that are used to transport materials into the confined space.

Cutting hazards due to personnel coming in contact with damaged internals.

11) Lighting

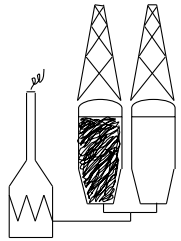
✓ Sufficient lighting is required to establish a safe work place (no trips, falls or injuries).

12) Potential for hazardous gas releases from surrounding equipment, activities and process unit facilities

✓ Unplanned gas releases can get drawn into the confined space and cause exposure to personnel or fire/explosion.

Opening Process Equipment

Confined Space Entry – Key Points (cont'd)



13) Confined Spaces within a confined space (for example, floating roof tank pontoons, enclosures inside vessels)

- ✓ Presents additional access and egress issues, and may contain hazards that impact the larger confined space, but are not readily obvious to the personnel in that space.

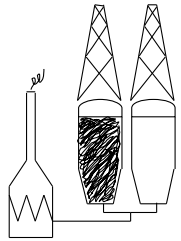
14) Live process lines or energy sources within or passing through a Confined Space

- ✓ Contact with hazardous energy or material in a confined space may result in fatal consequence
- ✓ Hazardous material leaking into the confined space through flange or gland, or due to damage caused by work execution can lead to potential injury of exposed personnel or fire/explosion

15) CSE Rescue

- ✓ Develop effective rescue plan for all potential scenarios.

Opening Process Equipment



Confined Space Entry (CSE) – Special Condition

Blind or physical disconnect not at the first flange off the vessel for Confined Space Entry. (Possibility of block valve(s) or connections between vessel and first flange for CSE)

RISKS:

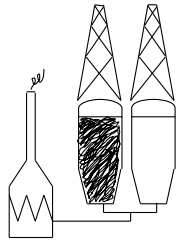
- Contaminants can enter the confined space through bleeders or other connections to the line, allowing asphyxiants or other materials to accumulate in the occupied confined space, where egress is difficult.
- Hazardous material can accumulate on either side of the block valve and expose personnel.

MITIGATIONS:

- Use the site process/procedure/tool (for example, decision tree) for evaluating an isolation location at a point other than closest to the confined space.
- Control of all connections between the blind and the vessel (refer to 2.3.2 i).
- Flush or purge the line with the intervening block valve open.
- For physical disconnects, require the installation of a face blind unless the opening to atmosphere is required for ventilation or some other purpose that does not introduce a hazard to the space.

Opening Process Equipment

CSE – Special Condition (cont'd)



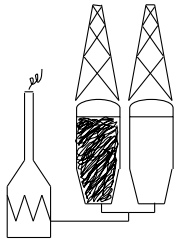
ACCEPTABLE ALTERNATIVES:

- Movement of the isolation location for a logical safety reason. (For example, to eliminate blinding in a vessel skirt).
- Blinding at the first available flange and only the bleeder designated as the EVP between the blind and the confined space. (For example a welded system).

EXTRA REVIEW AND APPROVAL IS RECOMMENDED
FOR SUCH AN ARRANGEMENT

Opening Process Equipment

Delayed Coker EI and OPE (cont'd)



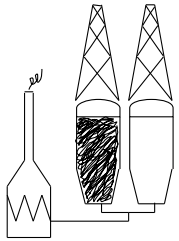
Hydraulically-powered **Grayloc flange closure devices** are still used on some coke drum feed lines

- This piping qualifies as open-ended piping. Leakage is prevented by two steam-purged specialty valves and a steam barrier in between.
- Workers will pass in front of the open-ended piping as part of normal bottom deheader work.
- Inadvertent opening of a valve is prevented by the coker PLC-permissive interlock system and the IE procedure.
- Should abnormal mechanical work be required in the bottom head area, with the other coke drum in service (either circulating resid, coking or decoking), which requires workers to be exposed to the open-ended pipe beyond the normal exposure window, then the Grayloc hub blind should be installed.
- This may not be possible (site dependent) should bottom head movement be required as part of the work, and the hub blind would interfere with movement of the head flange.
- In that case, the site should consider if additional precautions are warranted, such as a safety watch, limiting access to the work area, or additional lock-outs of energy.

Opening Process Equipment

Delayed Coker EI and OPE (cont'd)

Grayloc Flange Hub Blind Photos



Hub Frontside

Hub Backside