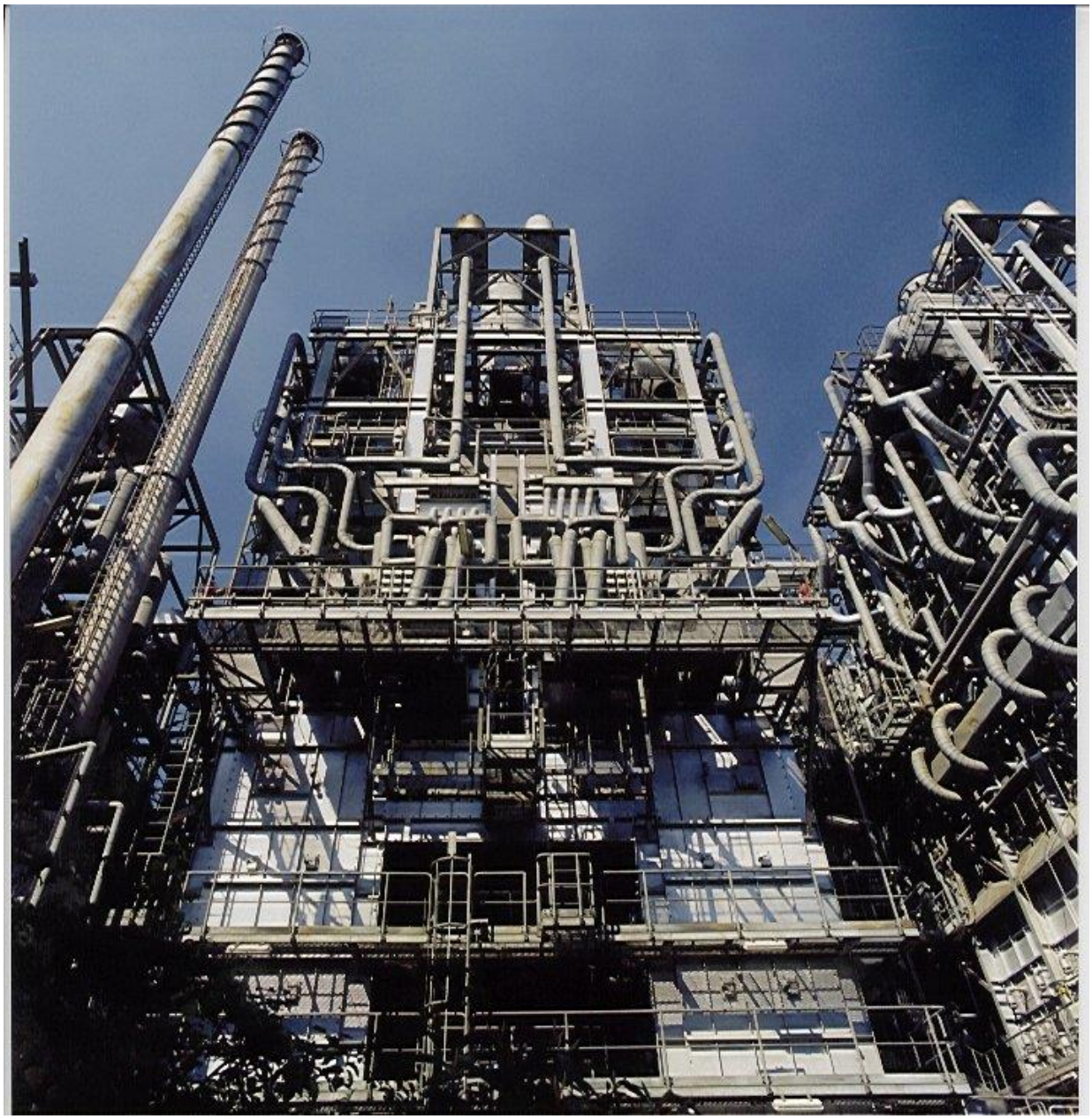
EUROPEAN ETHYLENE PRODUCERS COMMITTEE

Good Practice Document:
Confined Space Entry (CSE)

DOCUMENT PREPARED

BY THE EEPC ISSUE GROUP SHUTDOWNS & TURNAROUNDS



1. Management summary

Entering in a confined space is dangerous because of the risks from noxious fumes, reduced oxygen levels, risk of fire, execution of work and so on. Other dangers may include flooding/drowning or asphyxiation from some other source such as dust, grain, or other contaminant.

Wherever possible, carrying out tasks in confined spaces should be avoided as much as possible. Where this is not possible, the risks of the particular confined space must be assessed and planned how to control those risks.

The intention of the Good Practice Confined Space Entry (CSE) is to show methods, techniques how to avoid or reduce confined space entry. Those include cleaning-, scaffolding- and insulation-techniques.

If CSE's can't be avoided strong focus needs to be on increased safety and quality.

The following areas were taken into consideration for the good practice: Work preparations, emptying and isolation, first opening of manways and surveying during execution

As a starting point, every company should have a management guideline concerning all relevant issues regarding CSE. This should include targets which can be translated into action plans and tracked on a regular basis.

Table of Content

2. Reader

A **good practice or a practice worth replicating** is a technique, working method or activity that has proven itself to be more effective than other techniques and methods and can therefore serve as a reference for tackling a problem (to Wikipedia).

It is important for TAR organizations to know the "good practices" within their scope (preparing and executing TARs) and to be able to compare and adjust their own way of working. The traditional term “best practice” is not used in this document as it may imply that there is no opportunity for further improvements.

In the definition itself, there is an inherent notion that best practices are a snapshot of the state of knowledge and can be adjusted when information about (new) techniques and practices becomes available. The best practices of a certain organization are not necessarily the best practices for another organization.

A good understanding of the context, the preconditions and the critical success factors are essential when making choices.

This EEPC Good Practice document on Confined Space Entry is based on a screening of existing best practices and discussions among EEPC members and in reference to
Presentation EEPC Confined Space v1.
Disclaimer

Uwe Velten, BASF SE	EEPC Issue Group TAR
Wolfgang Klemmer, LyondellBasell	EEPC Issue Group TAR
Jacint Domenech, DOW Chemical	EEPC Issue Group TAR

3. Approach

We collected existing best practices from the members of the EEPC issue group "TAR & Shutdowns on their content.
And distilled relevant information for our EEPC-members in one CSE-document.

The following EEPC companies participated in this document:

- BASF
- BAZAN
- BP
- DOW
- ENI-VERSALIS
- EVONIK
- INEOS
- LYONDELLBASELL
- REPSOL
- SABIC
- TOTALENERGIES

4. Definition Confined Space

How do I determine if I am dealing with a "Confined Space"?

For an area to be defined as a confined space it must meet all three of the following criteria:

1) Limited Openings for Entry and Exit. A confined space may be difficult to enter and perform repair work, or general maintenance. If something goes wrong while you are inside a confined space, escape/rescue may be difficult. Just because a work area has more than one way of escape, does not necessarily mean it is not a confined space. If the space has limited ways to get in and out, it could be a confined space. An open top tank would have limited openings for entry and exit.

2) The Space is not Intended for Continuous Human Occupancy. This means that the space was designed to hold something other than people. Examples include equipment, tanks and manholes.

3) The Space is Large Enough for You to Enter and Conduct Work. If you cannot fit your body into the space, you cannot become trapped inside. But you could still die if you can enter your head inside

In order for something to be defined as a confined space, it must meet all three of the about definitions. According to the Occupational Safety and Health Administration (OSHA) if a space does not meet all three of the above definitions, it is not considered a confined space. https://www.osha.gov/laws-regs

The risks associated with confined space entry are manifold:

- The atmosphere and the oxygen concentration are a general risk for man entry requiring either intense monitoring or additional PPE.
- The atmosphere is not necessarily homogenous within the vessel. It can differ with the position and over time if there are some pockets of product left in nozzles or low points.
- People are feeling uncomfortable inside vessels when staying longer for work or inspection. The stress for the body is higher when performing the same work inside a confined space.
- The risk for stumbling, tripping or contusion is higher inside confined space due to space limitations, low lightness
- The number of near misses with a high potential is still high in context of Confined Space Entry
- Furthermore
    - Exposure to toxic components
    - Exposure to radioactive components

5. How to avoid or reduce entering confined space

Reasons for entering confined spaces are many, most relevant ones are the following:

Cleaning, Scaffolding, Inspection, Maintenance, Repair, Modifications

It is important to develop a Management Strategy concerning CSE

a) Management Guideline concerning CSE

A clear guideline by Management is key to drive improvements and support behavioral changes. Primary focus should be on reducing CSE; only in case it cannot be avoided a plan for safe entry shall be developed and implemented. Important is to have smart targets to ensure they can be translated into an individual actionable plan and tracked on a regular basis.

Possible considerations to reduce Confined Space Entry are:

- Increase interval between turnarounds
- Risk based inspections (RBI) as alternative inspections

Current status amongst the participants of EEPC TAR Issue Group is:

- Some companies have goals or policies defined by management to avoid/reduce entering confined spaces
- Some companies also setting ambitious targets to reduce confined space entries as much as possible
- Another practice is a target to reduce OCI- Scope (Open-Clean-Inspect) by 3% every year
- Each CSE need to be reviewed individually to verify its purpose and motivation:
  - Why is not it possible to execute the job from outside?
  - Are no machines available to do the job inside the confined space instead of people?
-
- Guidance to avoid CSE tourism (Unnecessary vessel entry!)
  - Only necessary and minimum # of people enter an equipment.
  - Access should only be granted to those people who must fulfill a task.
  - Tourism may also be minimized due to health risks
- Good practice is challenge and approval by leadership for each CSE.
  - Balance between the action and the risk to enter
  - Do you need to do the job?
  - Do you need to go in to execute the job?

Further learning points can also be found in the EEPC database of incidents in chemical industry.

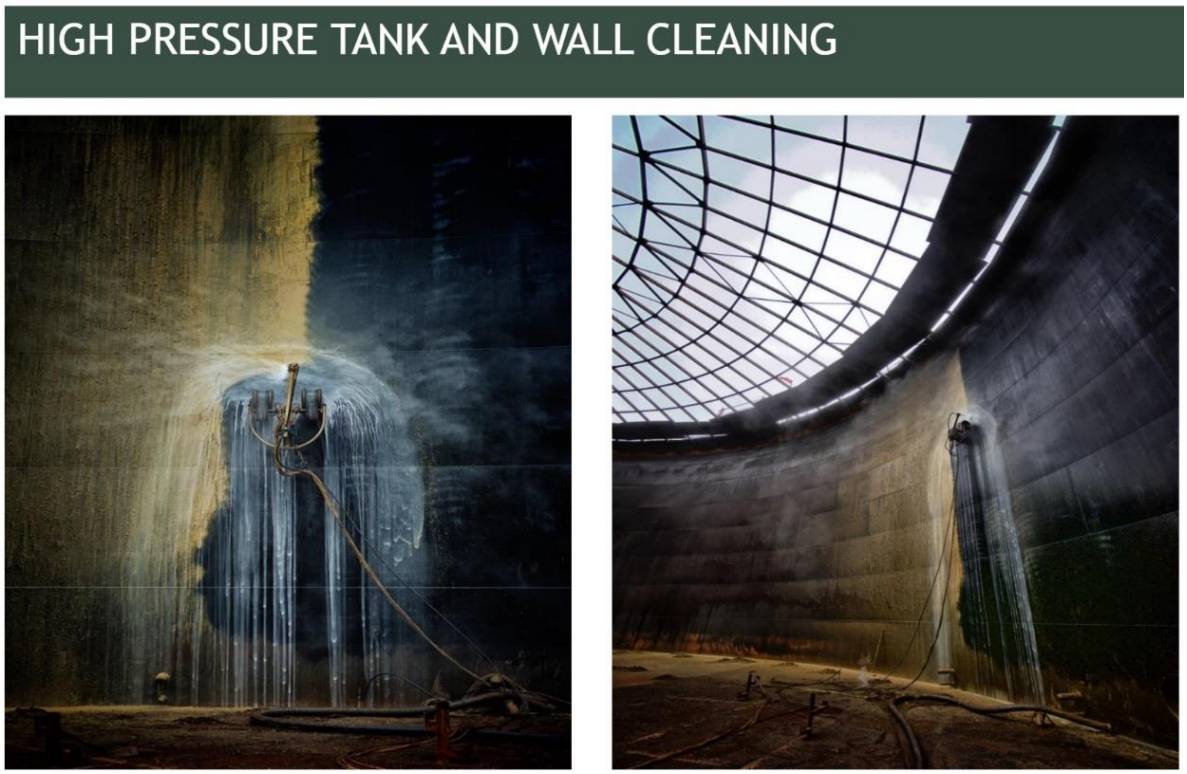
Furthermore, Site Management and TAR Management has to recognize that vessel entry is the exception during routine operations. Most of CSE are connected to either Turnarounds or Outages. This results in low corporate knowledge about CSE- related risks and a training on both technology and behavior needs to be implemented as part of the TAR onboarding.

b) Use of new techniques

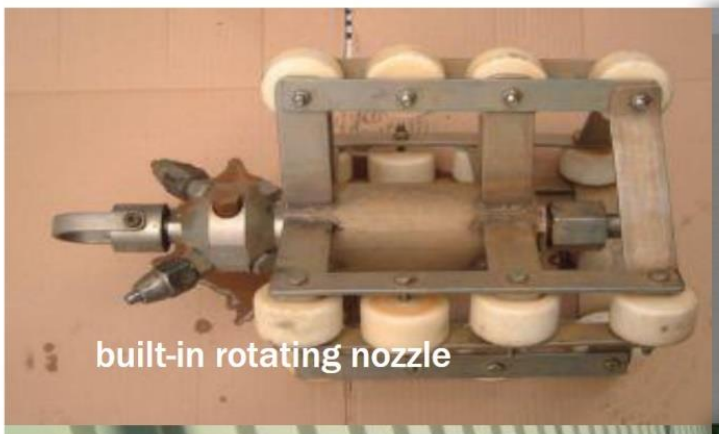
If cleaning is required as per job description, it is key that the planning lead or the TAR-Operations Lead reviews the method statement before a detailed work package is developed The leading questions for this review should be whether in the meantime (since the previous time this job was performed) conditions or circumstances have changed (new regulations or exposure limits, improved cleaning technologies available, lessons learned from similar jobs, …). With this review step, it will also be clear to participants that CSE is a critical task which requires in depth preparation.

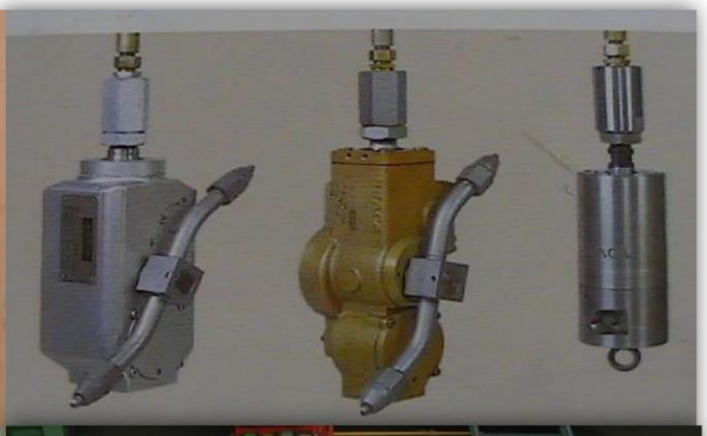
i. Cleaning

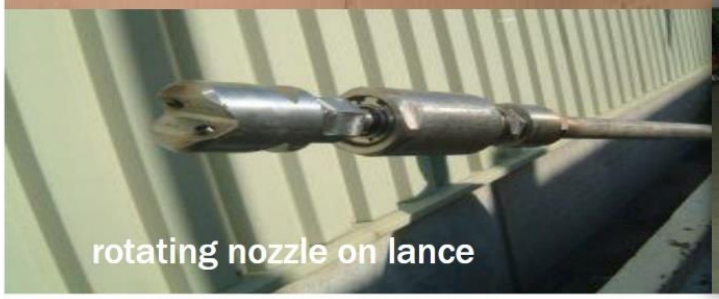
- Do you really have to enter for cleaning?
- Foresee additional cleaning openings and venting openings
- Robots, turning heads, spraying nozzles, ….
- Consider decommissioning improvements to reduce dirt. (Longer cleaning, higher temperatures, ….)
- Chemical cleaning with sample taking to be able to monitor and execute an efficient cleaning. Test the chemical cleaning product in advance to see if this is efficient.
- Online Cleaning of pipelines and towers in running plants
- Consider testing drain points prior to TAR or during decommissioning phase to ensure unit and equipment are fully drained and flushed.
- Use of smart pigs
- Prevent fouling (installing additional filters)



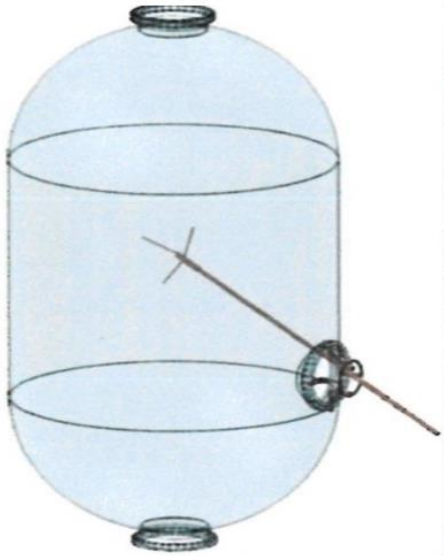
- With reduced entry:



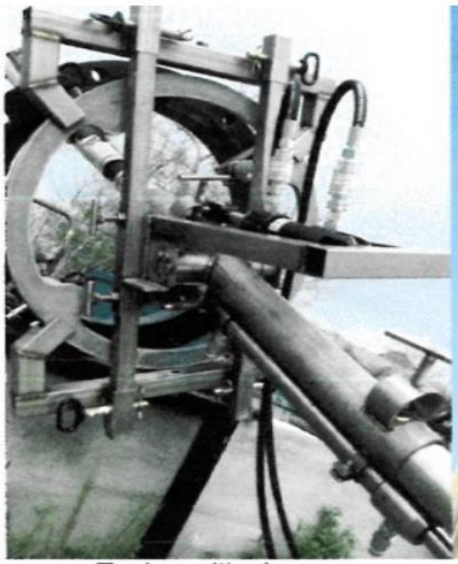




Without entry:



Tank positioning arm



Tank positioning arm

Tank spider

<u>Petrochemical equipment live online cleaning</u> using high pressure process fluids

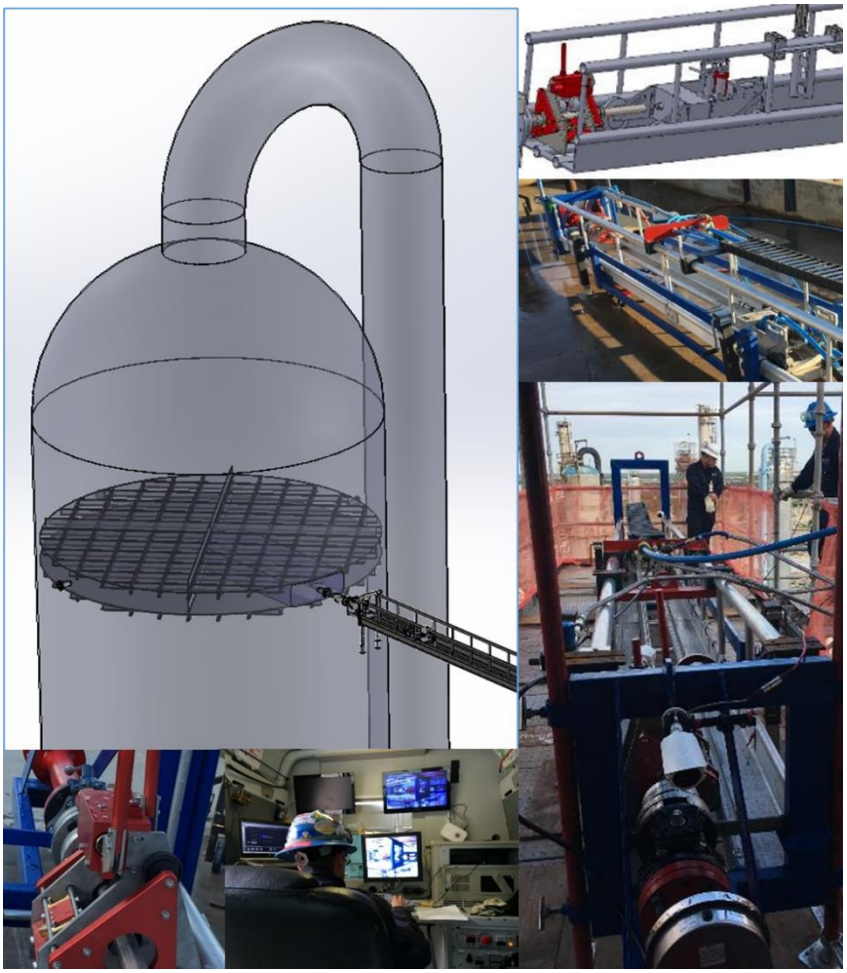
Sealed entry into live fractionators / quench towers / tanks

Large diameter trays with or without bubble caps at various elevations are cleaned effectively using high pressure process fluid jets (example: Diesel or HAS-Oil).

Using the Petro Jet Lancer Technology, the tower remains in service and can be restored to full productivity in most all cases.

The Petro Jet Lancer Technology includes:

- Fully automated “hands-off” operation
- Operation and monitoring from ground level (in most cases from specialized vehicle)
- Pressure monitoring safety valve diverting fluid back to storage tank in case of downstream pressurized fluid release
- Large cleaning coverage on trays due to high powered jets
- Cleaning head with integrated check valve to prevent back-flow
- Debris is downsized and fluidized in the process



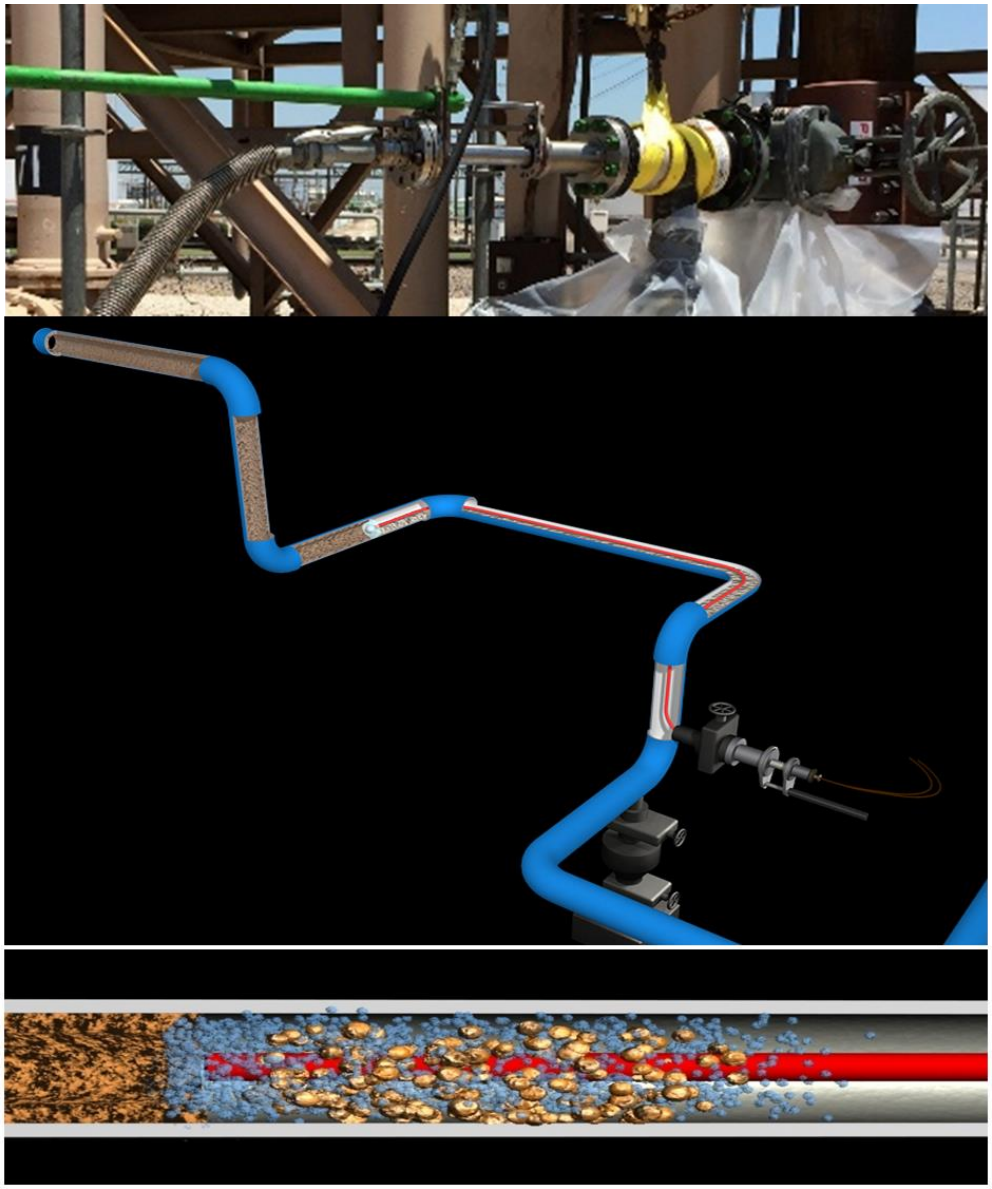
Pipe online cleaning

"Pipe-In-Operation" (PIO) – Aqua Milling® enters live piping systems when fouling compromises plant operation and shut-down is not an option. PIO-Aqua Milling® cleaning is mostly used in:

Flare header piping (small and large diameter) / Process piping / Cooling water piping

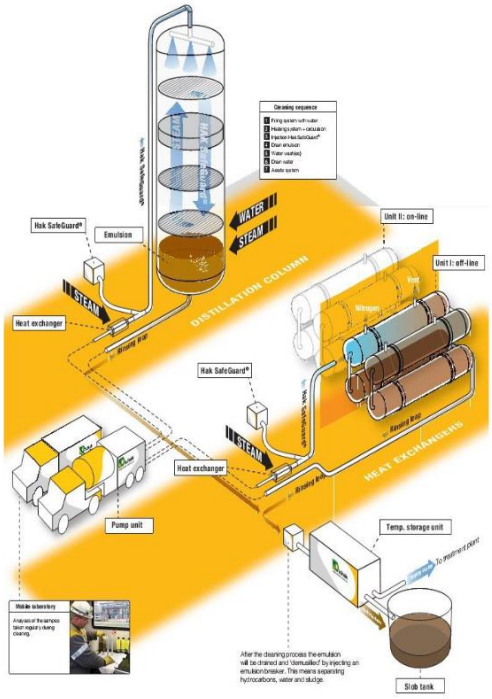
PIO Aqua Milling® includes:

Debris transported to scale collection trap / Dual seal with N2 locks / Hydraulic remotely controlled protection sleeve for hot tap entry / High temperature applications / High pressure applications



CHEMICAL CLEANING

- Pre-operational chemical cleaning:
  - Remove foreign material from construction:
    - Pickling (degreasing, metal collection and passivation), soaking or circulation method
- Maintenance chemical cleaning:
  - Remove polymers, pyrophoric, cancerogenic,… from operational fouling:
    - Degassing, decontamination in vapor phase
    - Degassing, decontamination by circulation
    - Foam cleaning



ii. Scaffolding

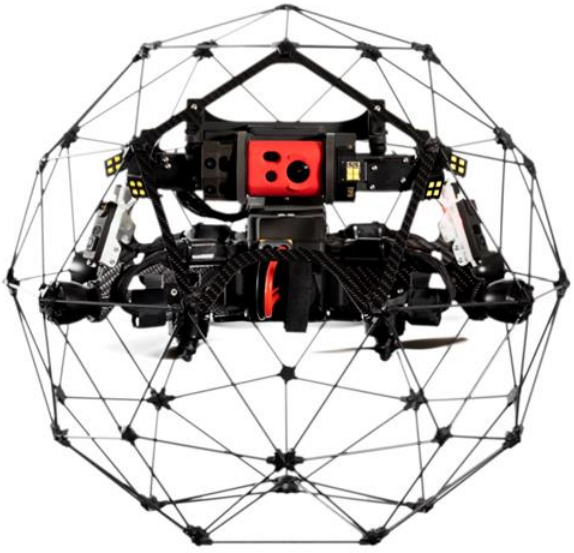
Reduce number of workers by using Rope access (no scaffolders)

iii. Inspections

Technical developments within the last years brought many good solutions to support safety and quality during inspections.

Examples are the following:

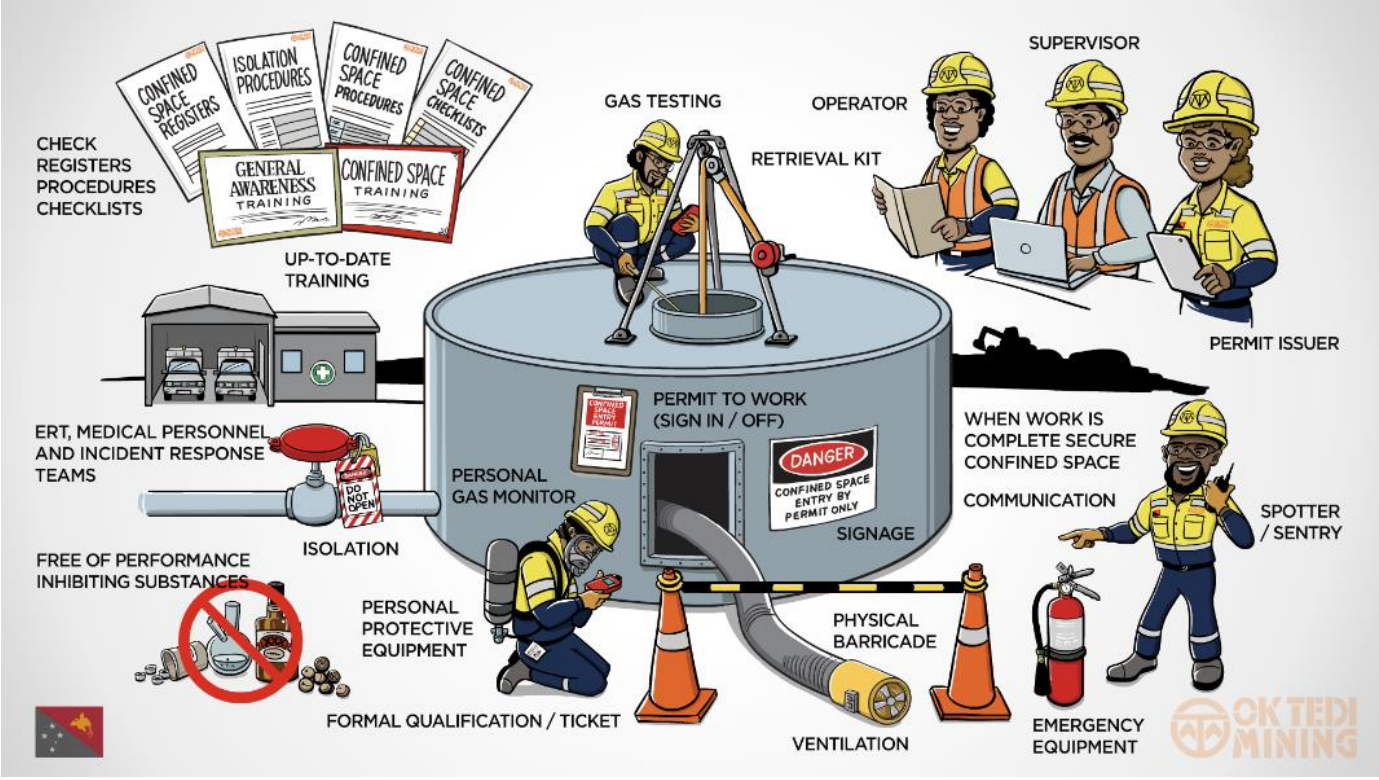
- Drones - video camera
- Robot inspections (e.g., cooling water system)
- Aquadrone (submarine with camera)
- Column Scans
- UT Corrosion Scanning
- Use of Snake Arms for inspection of smaller vessels
- Acoustic Emission Tests (X-ray, Eddy Current) instead of pressure tests
- Aquadrill to rinse fouling



Non-Destructive Testing (NDT) on a robotic platform

6. How to increase safety and quality during CSE

In case, CSE cannot be avoided, strong focus needs to be on increasement of safety and quality. The following visual shows various attention points to be considered before somebody enters a CSE.



The following areas are in consideration:

a) Work Preparations
b) Emptying & Isolation
c) First opening of manways
d) Surveying during execution

a) Work Preparations

- Detailed Risk based analysis and Specific Operatic Instruction for Confined Space Intervention, Prepare and Trained emergency response plan
- Rescue plan per entry prepared in advance
- Review rescue procedures by fire brigade/safety department
- Specific company contacted to do rescues
- Avoid any conflicting activities inside the equipment

- Best practice HSE Requirements CSE

It is key that the work preparation requirements are described as accurate as possible and that they are also part of onboarding for example in dry runs or desktop exercises for all participants. These requirements may also include quality assurance activities to verify the quality of work preparation and the robustness of the mitigation actions implementation.

b) Emptying and Isolation

- Emptying and isolation to be ensured by operations
- Specific decommissioning procedure per product/equipment
- Blinding list to be setup and checked
- Transfer actual situation to be ensured during shift transfer
- Digitalization can help ➔ see example DiGiBLOCK

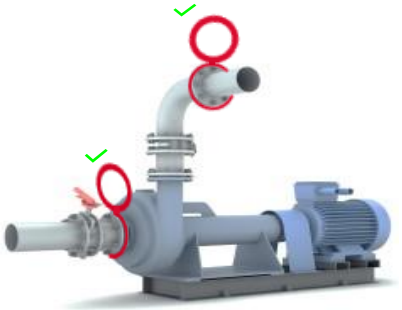
04 Applications

DigiBLOCK

Checking the current position of blinds

Goal: faster system release less paperwork

- ✓ Mobile solution
- ✓ Integrated with the existing Turnaround Management System (TMS).
- ✓ Show location on a map
- ✓ Add notes



ASSET PERFORMANCE 4.0

BASF We create chemistry

c) First opening of manways

Current status amongst the participants of EEPC TAR Issue Group are:

Example 1:

- Confirmation that column is free of hydrocarbons after emptying, purging and inerting via implementation of operating procedures
- Confirmation isolation method has been implemented (physical separation or blinding) in all connections as close as possible to the confined space, according to the plan
- Assure all documentation coming from risk assessments is available, well understood and people involved in the task are aware of it
- PPEs are available for people performing the first opening according to procedures and PPE grid
- The opening task is permitted by Operations

Example 2:

- Setting up clear rules of "1st line break"
- Everything is cleaned and flushed
- Preparing work permit
- Organizing work at the manway
- During opening of the first manhole, somebody from operations must be present at work spot
- After partly opening ➔ taking required samples (gas/oxygen measurements)
- If those are OK, complete opening of the manway
- Taking again sample (gas/oxygen measurements)
- ➔ If OK, work gets released to open all other manways

Example 3 (in addition to the above):

- Precheck whether equipment is fully drained (even if drain valve is fully open, some product could block the outlet): Use of external checks via US techniques could confirm that the vessel is empty or indicate a risk before opening the manway.
- Presence of operator during opening of manway

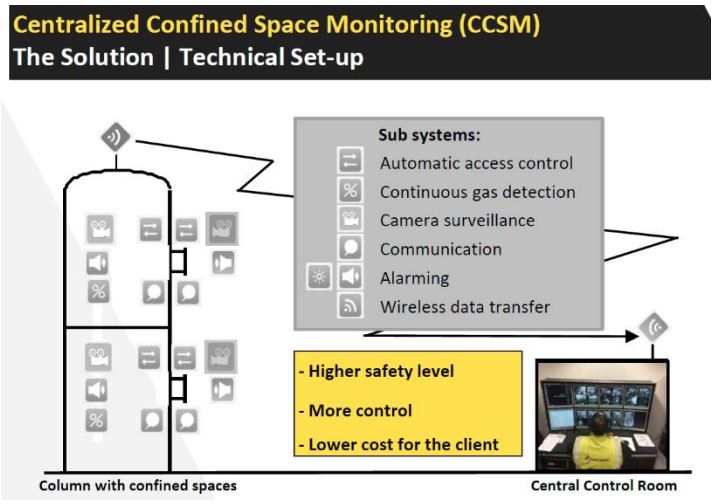
- Risk assessment to be done if it is necessary to be standby as operator during opening.
- At all-time need to be ensured that the right equipment will be opened.

d) Surveying during execution

Supporting occupational safety through continuous remote monitoring (centralized confined space monitoring CCSM) has been tested and implemented for several sites. This technology supports operations in their role to issue the permits to work. They also change the role of manhole watchers replacing field surveillance by remote surveillance. Nevertheless, there is still field personal required to respond to any abnormal situation within confined space or changes to existing plans.

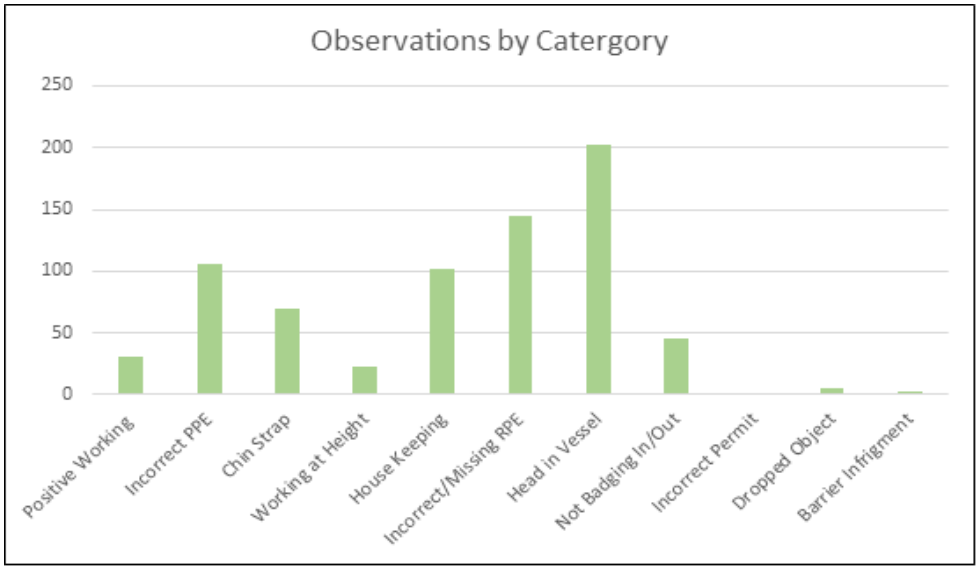
Centralized Confined Space Monitoring (CCSM)

Support of operations for more manpower availability



Positive side effect of Centralized Confined Space Monitoring:

Monitoring cameras can deliver additional data as listed in the graphic to the right.



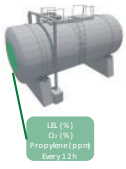
- Camera monitoring is seen as a practice worth replicating different approaches taking into account the legislation in the country.
- Gas- testing by contractor;
  Barcode- system for location- identification, wireless connection to permit- office
  Combination with safety watch.
- Gas measurements
  a. Depending to available technology, gas measurements are done manually (e.g., 1x per shift) or continuously via online measurements.
- Biomonitoring (separate presentation available on EEPC website)
- Digitalized gas analysis ➔ See picture DigiGas

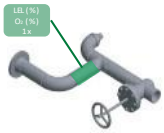
04 Applications

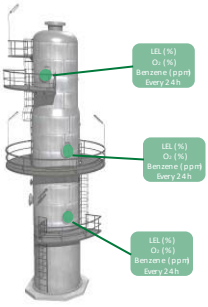
DigiGAS

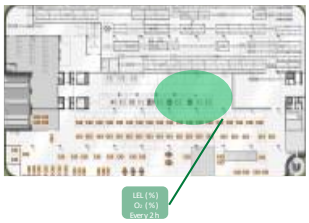
Integrated planning and management of gas analysis measurements

- Goal: faster availability and better management of analysis results
  - ✓ Web & mobile solution
  - ✓ Simple and clear management of the analysisresults
  - ✓ Show location on a map
  - ✓ Add notes









➢ Practical support methods

- Total: Patented pole system for emergency extraction of personnel in confined space (model developed by TotalEnergies staff and awarded with an internal award)

Internal

7. References & Contacts

a. References

- https://www.osha.gov/laws-regs
- Presentation EEPC Confined Space v1

b. Contacts EEPC

Mr. Philip De Smedt; Director Petrochemicals Europe at Cefic, pds@cefic.be

Mr. Kris Bakelants; Chairman EEPC Issue group TAR, kris.bakelants@basf.com