

# WHY SIL?

## *Use of SIL in the Design of Hydraulic Valve Actuators for FCCU's and Delayed Cokers*

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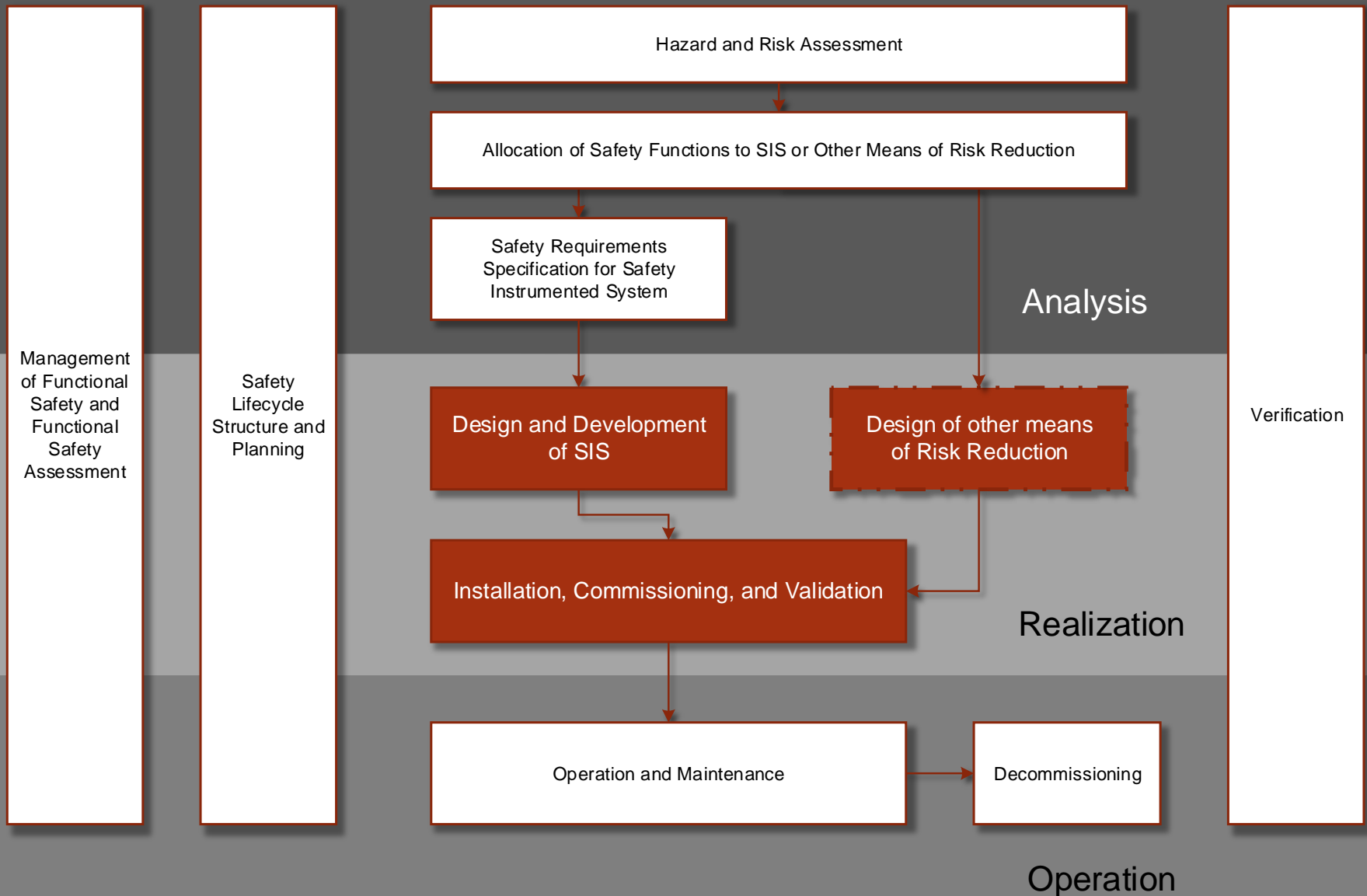
# Why are we here?

- Recent actuator projects request “SIL certified” systems
  - FCCU slide valves and Delayed Coker Unheading Valves
- SIL not applied properly to project in many cases
- Excessive design requirements and over-specification causes project costs to skyrocket
  - We wish to supply safe and optimum designs
- Results in higher project cost, without increased safety

# What is “SIL”

- **S**afety **I**ntegrity **L**evel
- Measurement of performance required for a Safety Instrumented Function (SIF)
  - Probability of Failure on Demand (PFD)
- IEC 61511 “Functional safety - Safety instrumented systems for the process industry sector”
  - Safety Life Cycle
  - SIL 1, 2, 3

# Safety Life Cycle





# Safety Instrumented Function

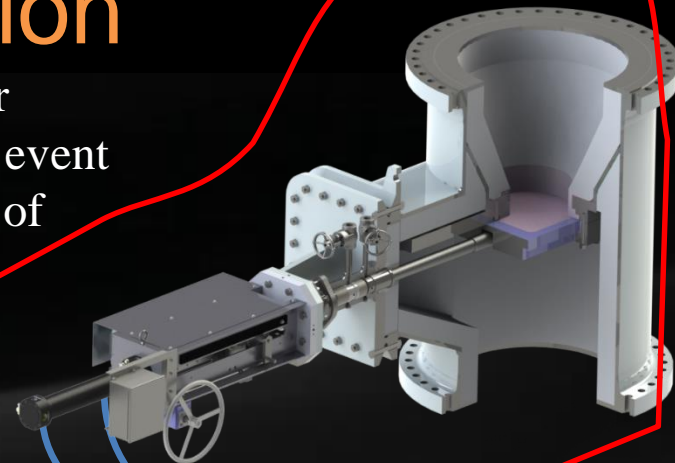
A SIF is designed to prevent or mitigate a hazardous abnormal event by taking the process to a state of lower risk.

Sensor(s)

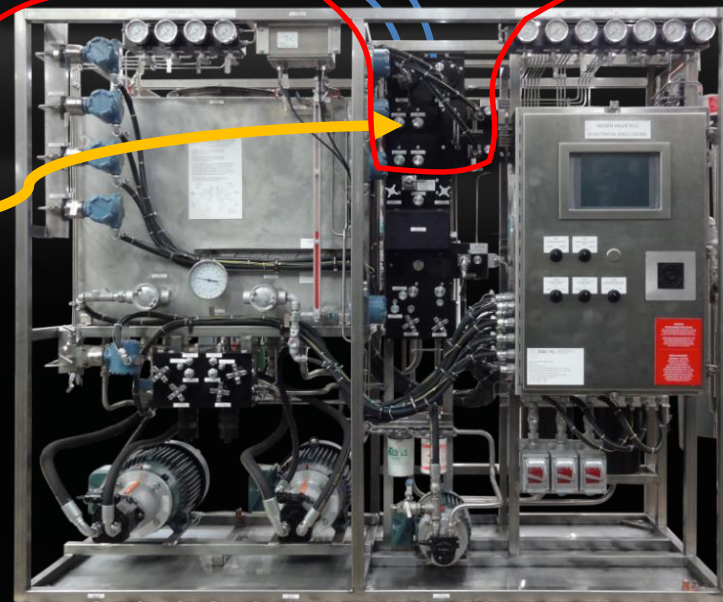


**This function  
can have a SIL**

Actuator



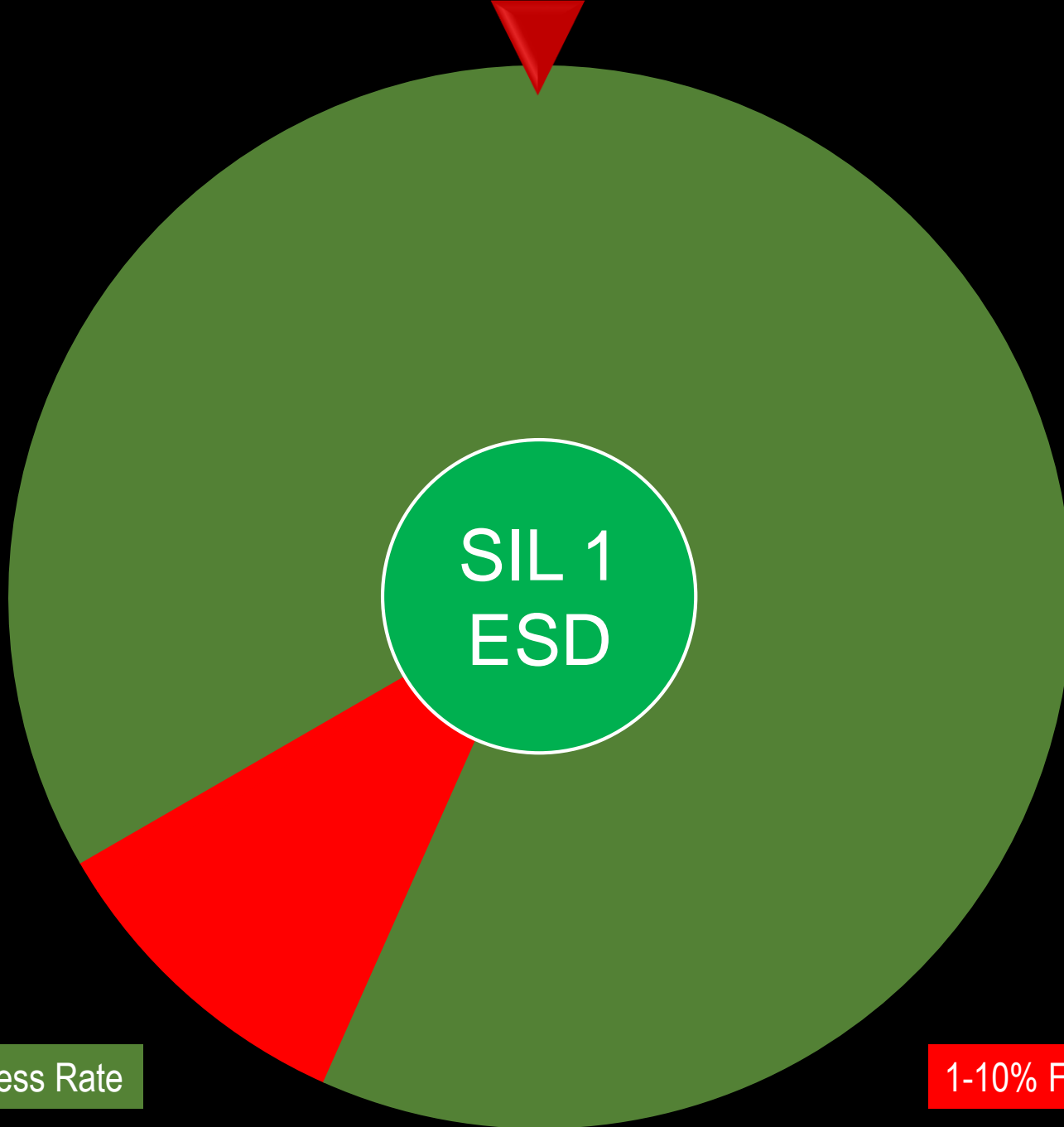
Logic Solver



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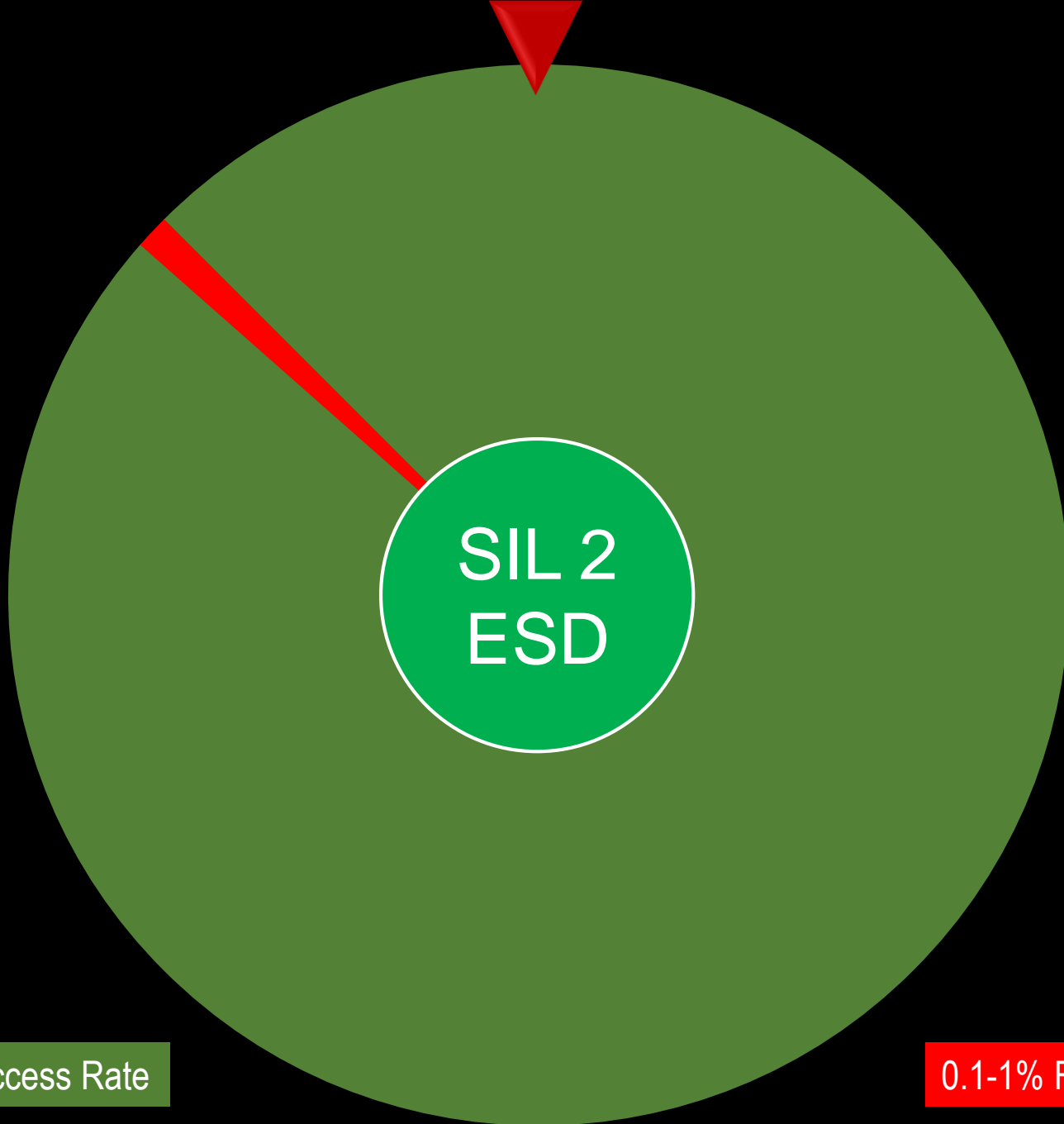
# SIL 1



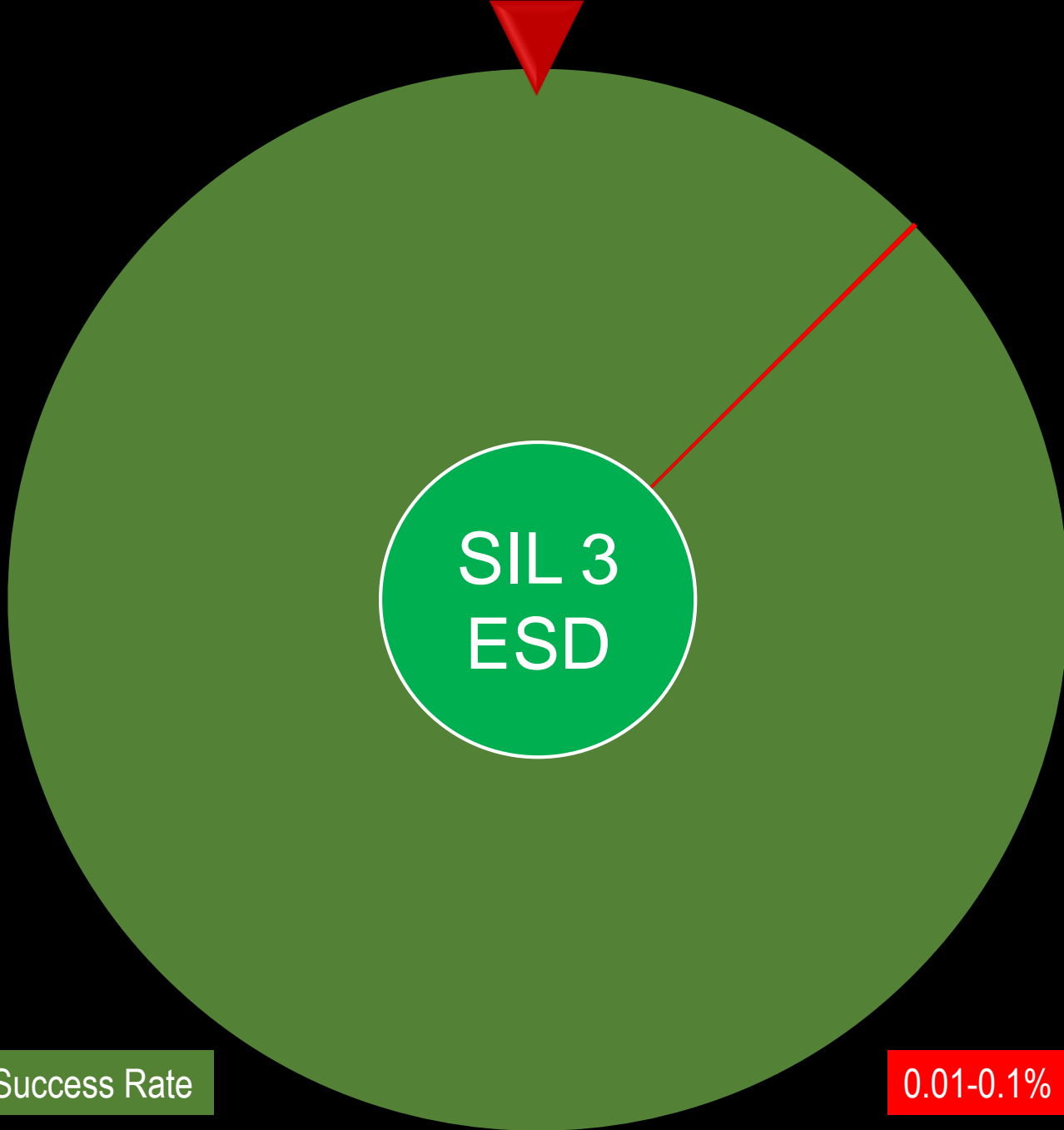
90-99% Success Rate

1-10% Failure Rate

# SIL 2



# SIL 3







How does this relate to FCC and DCU valve projects?

## FCC Slide Valve

- Continuously throttling for up to 6yrs
- Valve is process control, not pressure boundary
- ESD function critical to process protection
- Redundant and back-up systems required

## Delayed Coker Unheading Valve

- Cyclical on-off service
  - Strokes every ~12-18 hrs
- Valve is process pressure boundary
- ESD function doesn't exist
- Redundant and back-up systems in spec

## FCC Slide Valve

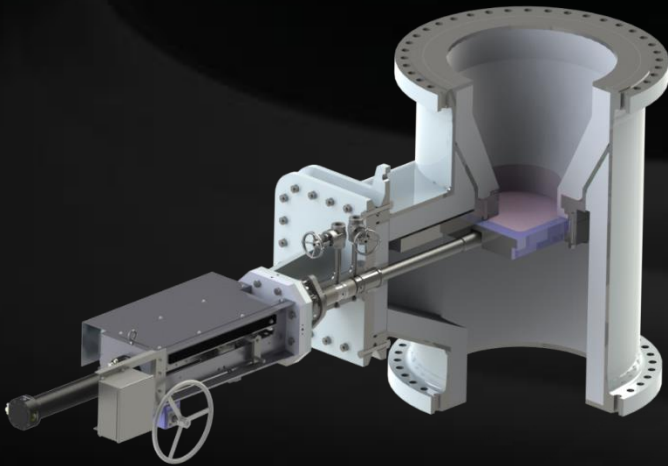
- Control is AUTOMATIC
- 5 s throttling / 2 s ESD
- Failure to control properly causes process upset
  - lost profits
- Spurious ESD
  - process upset
  - lost profits
- Failure to ESD
  - possible equipment damage
  - lost profits

## Delayed Coker Unheading Valve

- Control is MANUAL
- 4 minute stroke speed
- Failure to move properly
  - delays coking cycle
  - lost profits
- Unintended opening while in service is worst case scenario
  - loss of process containment
  - HSE consequences

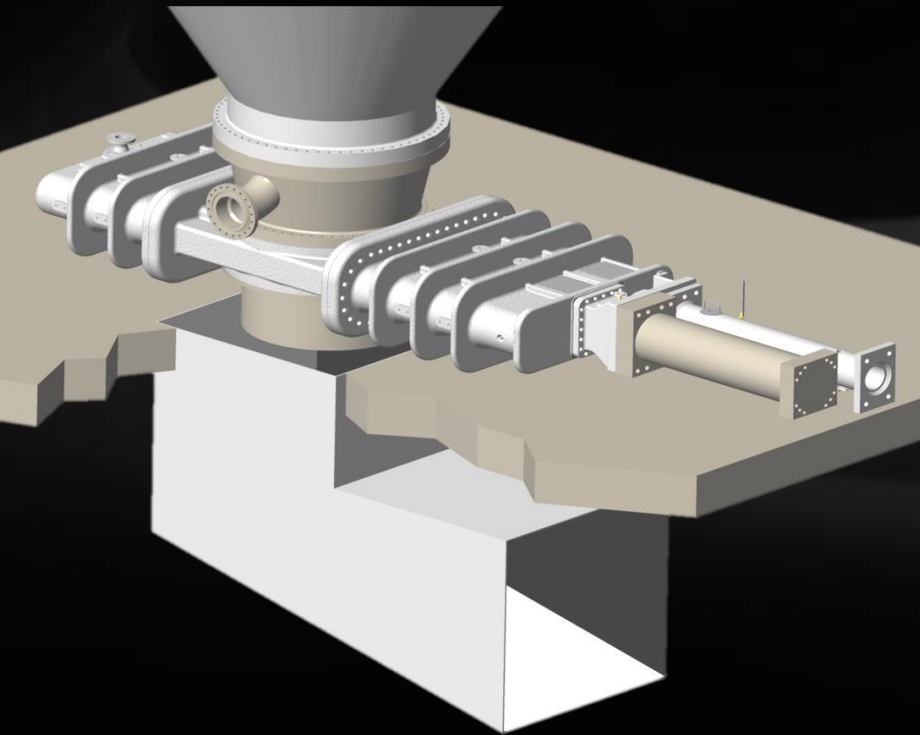


# Some FCC questions...



- Is the Emergency Shutdown function of a FCC slide valve a SIF?
- To meet a certain SIL, which parts of the hydraulic actuator system must meet the SIL?
- Does the valve positioning control play a role?
- Do level, pressure or temp transmitters on the hydraulic system need SIL certification?
- What can cause failure to ESD?

# Some DCU questions...



- Is the act of moving an Unheading Valve a SIF?
- Does the PLC that controls the HPU need to be a “safety” PLC? Is this PLC part of a “SIF”?
- Does the PLC that controls the coking cycle need to be a safety PLC?

# Recent 2 Drum Unheading Valve Project

- For this project, HPU only runs for 16 minutes every 24 hours
- Specs required SIL 2 rated “safety PLC” to operate HPU and HCU
  - Honeywell Safety Manager
  - 3 level transmitters for 2oo3 Voting on reservoir
    - Individual transmitters rated SIL 2 (99.9% availability)
    - Low level only prevents pump from running
  - Required all electrical output relays to be SIL 3 safety relays
    - SIL 3 relay to turn on lamps on local control panels



# Recent 2 Drum Unheading Valve Project

- Bid Package Prepared
  - Before SIL requirements were determined
- Specifications
  - All transmitters shall be SIL 2 minimum
  - All output relays shall be SIL 3
  - SIL 2 certificate for actuator required
  - All solenoids must be SIL 2
- SIL clearly used as a measure of quality of devices
  - End-User admitted that SIL won't be determined before equipment is delivered to site
- Vendors must comply with all specs
  - Exceptions and deviations are difficult to obtain
  - These "SIL" requirements increased project cost

# Some DCU answers...

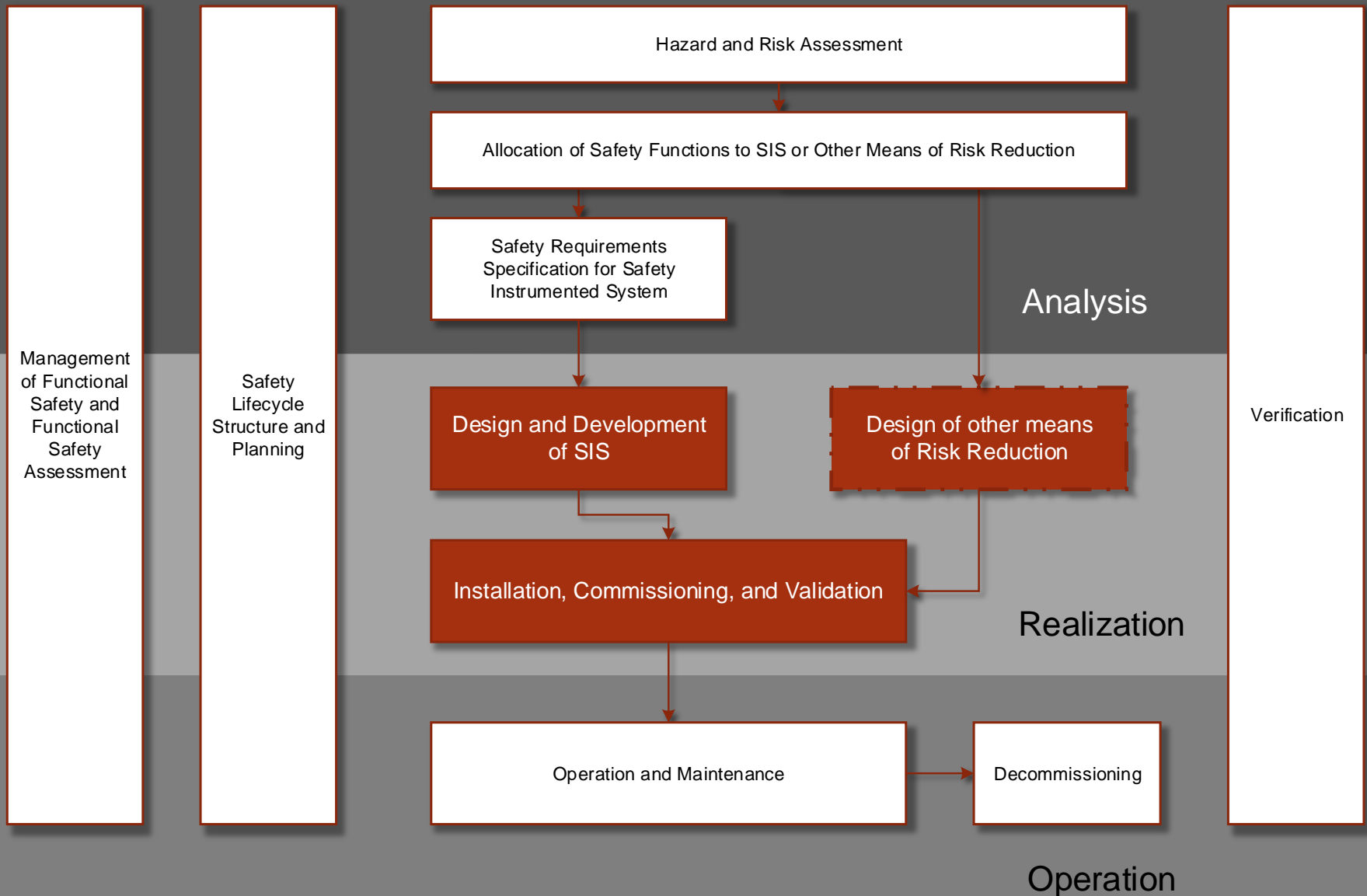
- Is the act of moving an Unheading Valve a SIF?
  - No. A SIF is used to prevent a hazardous abnormal event
  - Initiated manually by operator
  - Locking Pin
  - Energy required to move Unheading Valve
- Does the PLC that controls the HPU need to be a safety PLC?
  - No. The PLC turns on the pumps when commanded to move
    - Only when permissive to move from process SIS
    - Fail safe
- Does the process SIS need to utilize a safety PLC?
  - Yes! This gives the permissive to move to unheading valve
  - Ensures process valves are in the correct line-up



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# Safety Life Cycle



# Some FCC answers...

- Is the Emergency Shutdown function of a FCC slide valve a SIF?
  - Depends. Many think not. However, ESD failure has large economic impact, so it's treated like SIF
- To meet a certain SIL, which parts of the hydraulic actuator system must meet the SIL?
  - Hydraulic Accumulators, ESD solenoids, associated valving, check valves, hoses, etc.
  - SIL 2 capable
- Do the valve positioning controls play a role?
  - No. Slide valve ESD function is independent of positioning

# Some FCC answers...

- Do transmitters on the hydraulics need SIL rating?
  - **NO!! Transmitters do not initiate trip functions**
  - **Used for diagnostics only**
  - **ESD proof testing verifies diagnostic transmitters**
- What can cause failure to ESD?
  - **Loss of Hydraulic pressure**
  - **Solenoid valve sticks closed**
    - Dirty, overheated or other fluid composition issues
  - **Hydraulic valve doesn't move**
    - Dirty, overheated or other fluid composition issues
  - **Accumulator loses nitrogen**



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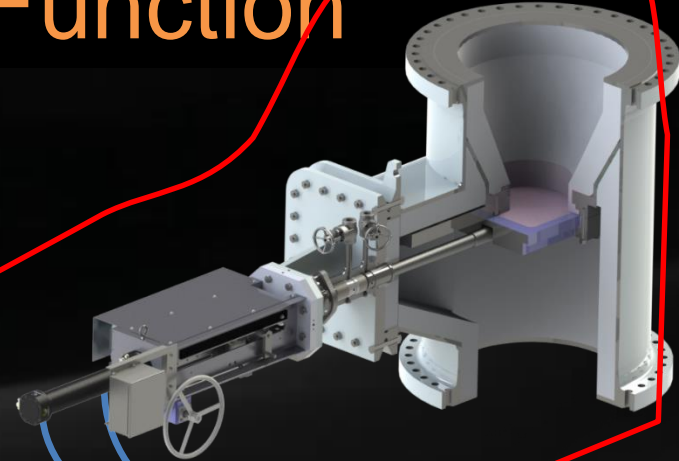
# FCC Safety Instrumented Function

Sensor(s)

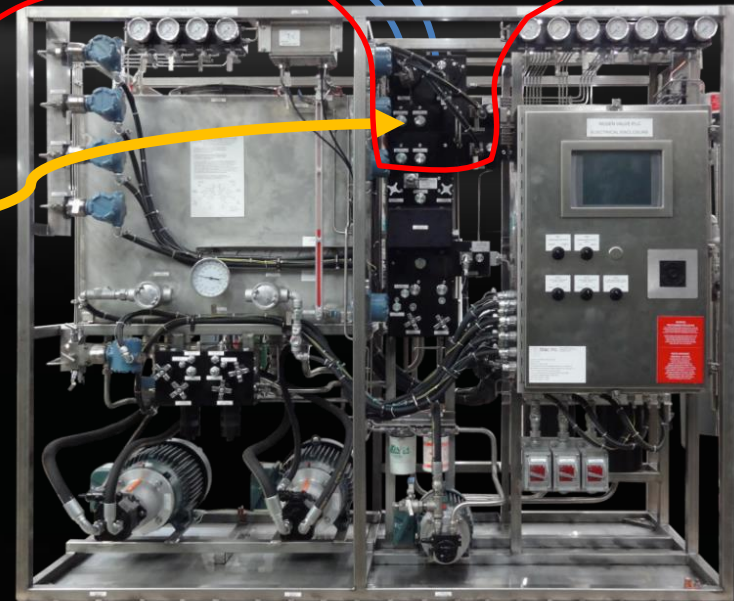


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Actuator



Logic Solver

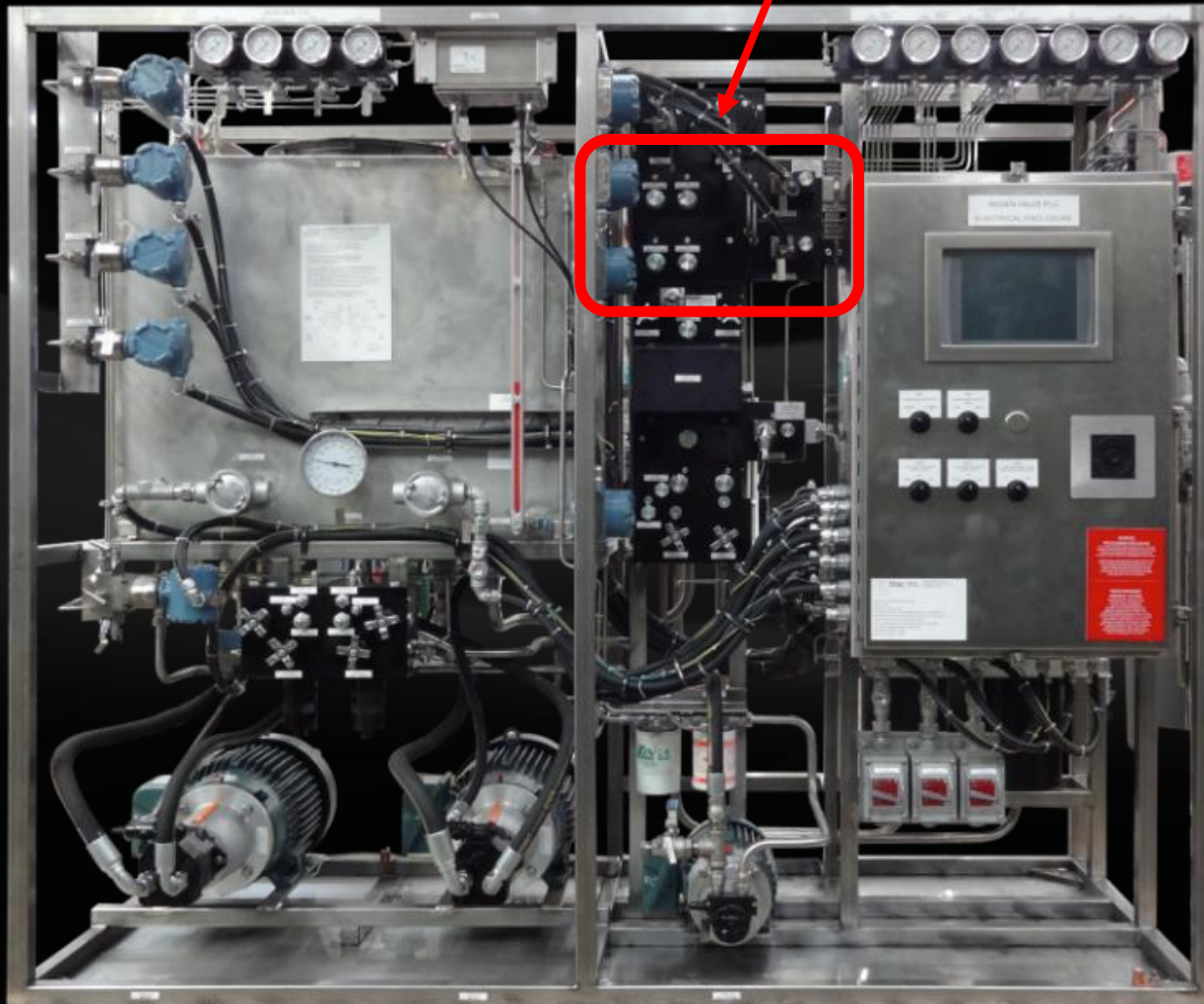


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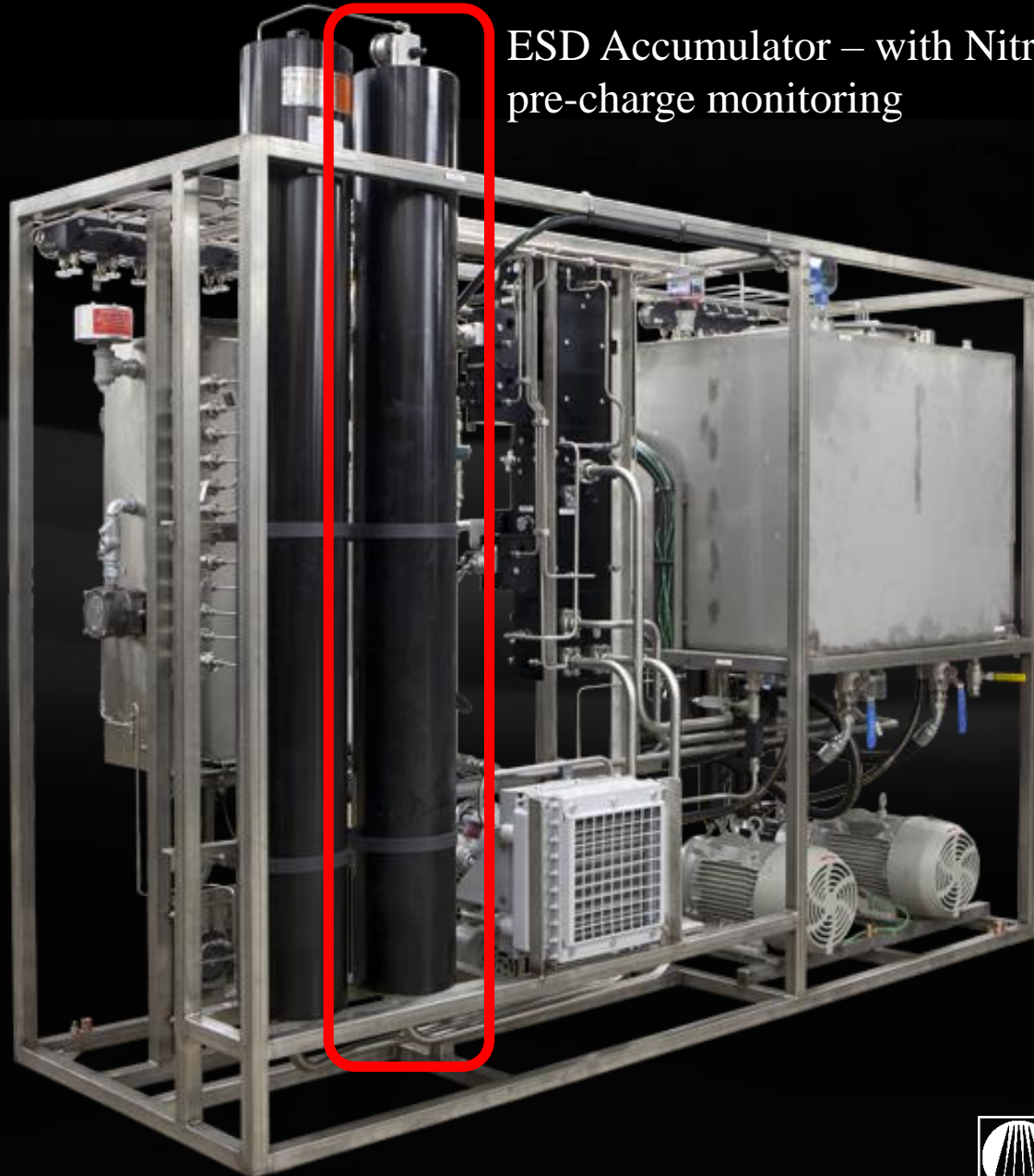
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ESD Solenoids – 2oo2 configuration



ESD Accumulator – with Nitrogen  
pre-charge monitoring



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# Preventative Maintenance for SIL

- Regular main fluid filter changes
- Regular circulation system filter changes
- Oil temperature in recommended range
- Regular monitoring of oil quality
  - Particulate content
  - Contaminants
  - Composition
- ESD Function testing
  - Test interval determined by SIL calculation
    - Test solenoid function only
    - With handwheel locked, full ESD trip test

# Conclusions

- FCC Actuator ESD Functions are Capable of SIL 2
  - Maintaining SIL 2 requires proper PM
  - 2oo3 voting solenoids are available at higher cost
- Coke Unheading Actuator System is NOT a SIF
  - Manual initiation of unheading valve movement
  - SIL not applicable to valve movement
  - Locking Pin prevents valve movement

# Thank You!