WHY SIL?
Use of SIL in the Design of Hydraulic Valve Actuators for FCCU’s and Delayed Cokers

Neal Cammy
Engineering Manager, BLAC INC.
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”

- **Safety Integrity Level**
- 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 Instrumented Function

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

This function can have a SIL
SIL 1 ESD

90-99% Success Rate

1-10% Failure Rate
SIL 2

99-99.9% Success Rate

0.1-1% Failure Rate
SIL 3

99.9-99.99% Success Rate

0.01-0.1% Failure Rate
How does this relate to FCC and DCU valve projects?
<table>
<thead>
<tr>
<th>FCC Slide Valve</th>
<th>Delayed Coker Unheading Valve</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Continuously throttling for up to 6yrs</td>
<td>• Cyclical on-off service</td>
</tr>
<tr>
<td>• Valve is process control, not pressure boundary</td>
<td>– Strokes every ~12-18 hrs</td>
</tr>
<tr>
<td>• ESD function critical to process protection</td>
<td>• Valve is process pressure boundary</td>
</tr>
<tr>
<td>• Redundant and back-up systems required</td>
<td>• ESD function doesn’t exist</td>
</tr>
<tr>
<td></td>
<td>• Redundant and back-up systems in spec</td>
</tr>
</tbody>
</table>
**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
Safety Life Cycle

Hazard and Risk Assessment

Allocation of Safety Functions to SIS or Other Means of Risk Reduction

Safety Requirements
Specification for Safety Instrumented System

Design and Development of SIS

Design of other means of Risk Reduction

Installation, Commissioning, and Validation

Operation and Maintenance

Decommissioning

Analysis

Realization

Operation
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
FCC Safety Instrumented Function

Sensor(s)
Logic Solver
Actuator

This function can have a SIL
ESD Solenoids – 2oo2 configuration
ESD Accumulator – with Nitrogen pre-charge monitoring
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!