The Importance of Standards to the Future of the Hydrocarbon Processing Industry

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### Industry Trends Impacting Process Operations

**Refinery losses - upward trend**

<table>
<thead>
<tr>
<th>Years</th>
<th>Refinery Losses</th>
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<tbody>
<tr>
<td>1972 - 1976</td>
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<td>1977 - 1981</td>
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<td>1982 - 1986</td>
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<td>1992 - 1996</td>
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<td>1997 - 2001</td>
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<td>2002 - 2006</td>
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<td>2007 - 2011</td>
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Source: Energy Practice of Marsh Ltd, a division of Marsh McLennan

**Skills leaving the workforce**

- 10,000 ‘Baby Boomers’ per day retiring over the next 20 years
- 400,000 years of experience being lost per day

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**Start up and shutdown events continue to be significant causes of refinery losses**
Incidents – Can Operators Cope?

Operator error or overload?

**Three Mile Island, 1979**
“the principle cause was human error”

**Texaco, Milford Haven, 1994**
Operators had to recognize, acknowledge and act on 275 alarms in 11 minutes

**Kern Oil Refinery Bakersfield, 2005**
Workers over pressurized a pump casing which resulted in an explosion

**Ciniza Refinery Gallup, 2004**
A shut off valve was not closed as required which caused a release of flammable liquids and caused subsequent explosions
Now Try Operating a Plant the Same Way!
Is This a Good Operator Interface?

Where are the alarms – are they critical?
Flexibility in Operations is Important

- **Startup**
  - Frequency
  - Operator skill & experience

- **Shutdown**
  - Scheduled vs. Unscheduled
  - Operator skill & experience

- **Feedstock and product transitions**
  - Crude sourcing
  - Campaign based production

- **Managing abnormal conditions**

- **Changing unit feeds & products**

- **Cycling of equipment**
Operators Need Help

Manufacturers have realized that standards save money and lives
- Consistent and Safe Operations Companywide
- Knowledge Retention
- ‘Act Instinctively’

How many plugs or adaptors do you need?

Manufacturers are taking part in and driving more industry standards

Smart phones work anywhere in the world
Standards Based Decision Support

- Display - ISA101 HMI Management
- Detect - ISA18.2 Alarm Management
- Take Action - ISA106/88 Procedure/Batch Management
Comprehensive Alarm Management (ISA18.2)

ISA18.2 Lifecycle

Ensure the right alarms are detected
Either the operator or the system can take action

Limit alarms to what the operator has time and ability to handle

Alarm Philosophy

Alarm Rationalization

Continuous monitoring and optimization
ISA18.2 Alarm Management Lifecycle

- Philosophy
- Identification
- Rationalization
- Detailed Design
- Implementation
- Operation
- Monitoring & Assessment
- Maintenance

Management Of Change

Audit
Advanced HMI Management (ISA101)

CONTINUOUS WORK PROCESSES

 ENTRY

**SYSTEM STANDARDS**
- Philosophy
- Style Guide
- Toolkits

**DESIGN**
- User, Task, Functional Requirements
- Console Design
- HMI System Design
- Display Design

**IMPLEMENT**
- Build Displays
- Build Console
- Test
- Train
- Commission
- Qualification

**OPERATE**
- In Service
- Maintain
- Decommission

**ISA101 Lifecycle**

- Continuous Improvement

Design Based on Operator Tasks
- Incorporate Human Factors (color, layout, navigation)
- Provide Situational Awareness (trends, profiles)
- Clear Indications – Items That Need Attention
This is a Good Graphic

- No contrasting colors
- Easy to identify alarms
- Information in context
- Low density
Issues with Procedure Automation

Many attempts at automating procedures have not met expectations
- Legacy programs and control systems
- Minimal structure and documentation
- Modification difficulties

Lack of confidence by operators
- Revert to using manual procedures out of frustration and inflexibly of the automated procedures
Committee formed in 2010 in response to these industry issues

Three technical reports, then a standard

TR1 – Models and Terminology

TR2 – Work Processes (Lifecycle of Automated Procedures)

TR3 – Examples of Automated Procedures

User driven committee with representatives from most of the major energy companies in upstream, downstream and chemicals
Capturing Procedural Knowledge

Much “procedural knowledge” is in the heads of the most experienced operators.

They have their own tweaks that are often not in the SOPs or are their interpretation of an SOP.

Automated procedures can capture the knowledge of the best operator on his/her best day...every day!
Procedure Management (ISA106)

Capturing Best Practices Procedures

Preserving Procedural Knowledge

“Having your best operators all day, every day”

- Modular approach
- Hierarchy of Procedures
- Re-use of Procedural Logic
- Multi-site Consistency
- Scalable Approach
Modular Procedural Automation

→ MPA is Yokogawa’s approach to procedure automation
  → Consultative methodology
  → Document and automate procedure operations in continuous processes
  → Modular design approach
  → Standardized implementation within sites and across companies

→ Standardize and Automate Procedures
→ Improve Plant Operating Efficiency
→ Improve Safety of Plant Operations
What Types of Procedures are Automated?

- Routine planned process changes and operations
- Unit startups and shutdowns
- Assistance to operators during facility upsets

Consider procedures that are performed frequently

Consider procedures that can help avoid significant losses or produce significant gains (Financial, Safety, or Environmental)
Hazards Associated With Delayed Coker Operations

- Specific operational hazards
  - Coke drum switching
  - Coke drum head removal
  - Coke cutting (hydro blasting)

- General operational hazards
  - Coke transfer, processing and storage
Personnel Safety is Paramount

- Coke Drum Switch Safety Interlock System (CDSSIS)
- Coke Cutting System Safety Interlock System (CCSSIS)
- Physical Barriers at Coke Drum Top & Bottom Levels
- Remote Unheading
- Coke Cutting Tool Auto Switch
- Reliable Coke Drum Level Indication
- Fire Safety System on the Coke Drum Structure
- Operator Training & Awareness
- Innovative shop floor Ideas
- Standard Operating Procedures
Coke Drum Switching

- Multiple drums, many valves
- Differences in valving
  - Difficult to distinguish and can lead to unintended drum inlet or outlet stream routing
- Valve control stations, for remotely activated valves, may not always clearly identify the operating status of different drums and modules
- Activating the wrong valve because of mistakes in identifying the operational status of different drums and modules has led to serious incidents
<table>
<thead>
<tr>
<th><strong>Coke Drum Switch Safety</strong></th>
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<tr>
<td><strong>Permissive for Coke Drum ‘Feed Isolation Valve’ operation</strong></td>
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<td>The ‘Feed Isolation valve’ of a particular Coke Drum will operate only when</td>
</tr>
<tr>
<td>1. Coke Drum top cover is closed</td>
</tr>
<tr>
<td>2. Coke Drum bottom cover is closed</td>
</tr>
<tr>
<td>3. ‘Switch valve’ is in ‘BYPASS’ or ‘OTHER COKE DRUM’ mode</td>
</tr>
</tbody>
</table>

| **Permissive for Coke Drum ‘Drain Valve’ operation** |
| The ‘Drain valve’ of a particular Coke Drum will operate only when |
| 1. Coke Drum top cover closed |
| 2. Coke Drum bottom cover closed |
| 3. Coke Drum feed isolation valve closed |

17th April’ 12

| **Permissive for ‘Switch Valve’ operation** |
| The ‘Switch Valve’ will not move towards a particular Coke Drum until |
| 1. Its ‘Feed Isolation valve’ is open |
| 2. Both its ‘Vapor valves’ are open |
| 3. Its ‘Drain valve’ is closed |

| **Permissive for Coke Drum ‘Heading/ un-heading’** |
| Heading & un-heading operation of the Coke drum will be allowed only when |
| 1. ‘Feed Isolation valve’ closed |
| 2. ‘Vapor valves’ closed |
| 3. ‘Blow down isolation valves closed’ |
| 4. Switch valve in ‘BYPASS’ or ‘OTHER COKE DRUM’ mode |
| 5. Vapor temperature is ‘safe’ |
| 6. Coke Drum pressure is ‘safe’ |
Averting and Controlling Possible Hazards

- Conduct human factors analyses to identify, evaluate, and address potential operator actions that could compromise the safe operation of the coke drum system.
- Provide interlocks for automated or remotely activated valve switching systems.
- Provide interlocks for valves that are manually operated as part of the switching/decoking cycle to avoid unanticipated valve movement.
- Color code and clearly label valves and control points to guard against incorrect identification.
- Provide indicator lights at valve and valve control stations to help the operator determine which is the correct valve station for the intended operator action.
- Use the “buddy system” (employees working in pairs) to help verify accurate valve or switch identification.
- Conduct periodic and documented training focusing on the importance of activating the correct valve or switch and the consequence of incorrect activation.
- Apply MPA (Modular Procedural Automation) to ensure the ‘best operator’ is running the plant 24x7.
Delayed Coking – Drum Cool Down

**EXAPILOT**

**COKE A DRUM COOLING PROCEDURE**

**EXAPILOT START**

**TA-XXXX RUNNING CHECK**

**COOLING START (MIN FLOW INJECTION)**

**WATER FILLING START**

**WATER FILLING END (LIIXXX XX% REACH)**

**PP-XXXX STOP**

**EMERGENCY BUTTON**

**TOTAL RUNNING TIME**

0 HR 5 MIN

**ALARM LIST**

**Interlock V/V CHANGE**

**MP8 18-FCXXX CLOSE**

**XX m3/hr HOLD TIME DELAY**

**PIXXX HIGH, FLOW DOWN**

**PIXXX(PV **** < SET XX**

**XXX->XXX INCREASE DELAY**

**LIXXXX FILLING DELAY**

**COKE B DRUM COOLING PROCEDURE**

**CHECK POINT**

WATER FLOW 18FCXXX.PV

PRESSURE 18PIXXX.PV

18TIXXX 18TIXXX.PV

FCXXX MODE 18FCXXX.MODE

LIXXX 18LIXXX.PV

LIXXX 18LIXXX.PV

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Delayed Coking – Drum Cool Down

**Diagram:**
- **WATER FLOW Increasing**
- **Need to SWITCH**
- **MODE:** AUTO -> MAN
- **Reach LIXXX/XXX XX%**
- **FCXXX MV - X % / XX sec**
- **WATER FLOW (18FOXXX)**
  - (m3/hr)
- **Check PRESSURE over X KG**

**Legend:**
- **XX m3/hr**
- **+ X m3/h / X min**
- **- slowly for X hr**
- **xx m3/h / x min**
- **MV XX. % OPEN**

**Notes:**
- **REFCOMM April 2014**
- © Yokogawa April 2014
- YOKOGAWA
A refinery operations team recognized there was a large optimization opportunity to automate a feed switch.

Benefits in automating the feed switch procedure were:

- Operator workload reduced by 60%
- A 42% reduction in product yield loss
- Increased feed throughput during transition by 18%
- Reduced feed switch transition time by 36%

Console Operator Moves per Hour Comparison from paper “Improving Refinery Unit Transitions Using Process Automation Technology in a base Oil Hydroprocessing Facility.” AIChE Spring 2011 Robert M. Tsai, Chevron, Richmond, CA
Purpose

- Operator workload was higher than in normal operations
- Operation time and product quality depended on the skills of operators

Ramping Techniques

- Junior operators
  - Ramp feed temperature linearly at the same rate
- Veteran operators
  - Change the ramping rate according to the temperature zone
90% of manual operations were automated
All monitoring was automated
2000 unnecessary alarms were suppressed
  - Operators can do other work during crude switchover
  - Missed steps and missed procedures were prevented
  - Safer operation was achieved

Number of PCS operation by operators

Done by operator

<table>
<thead>
<tr>
<th></th>
<th>LGO to HGO</th>
<th>HGO to LGO</th>
<th>LGO to HGO</th>
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<tbody>
<tr>
<td>31 March</td>
<td>151</td>
<td>116</td>
<td>106</td>
</tr>
<tr>
<td>2 April</td>
<td>50</td>
<td>50</td>
<td>50</td>
</tr>
<tr>
<td>5 April</td>
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Done by MPA

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Summary

Operators are leaving the workforce and taking key skills with them.

Newer operators are expected to come up to speed faster.

Standards can help to capture the knowledge of the veterans.

Standards make knowledge transfer easier and more effective.

Modularizing and automating procedures makes changes faster, safer and more reliable.