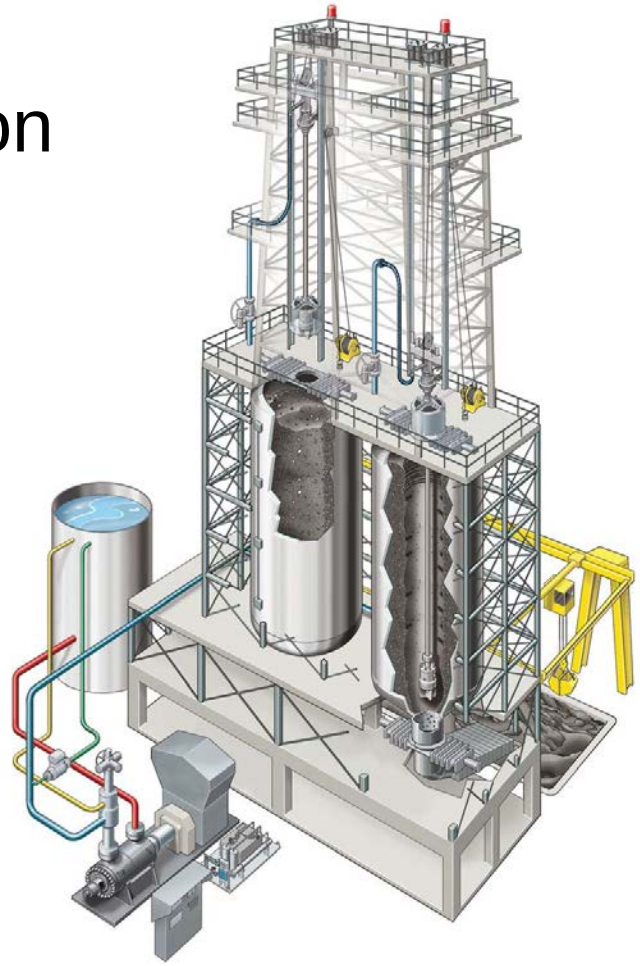
Flowserve
Remote & Automated Coke Cutting

Andrew Worley
Global Product Manager Coke Cutting Systems

Agenda: Remote & Automated Cutting

- Flowserve Overview
- Coke Cutting Process Evolution
- Coke Drum Monitoring
  - Audio
  - Video
  - Vibration
- Remote Coke Cutting
- Automated Coke Cutting



FLOWSERVE

Hydraulic Coke Cutting Systems History

1938 Process patented by Shell

1938 Original Jet pumps & valves by WORTHINGTON

1940 PACIFIC® *enters the market*

1947 First Pacific Pump Decoking Installation

1979 First Combination Cutting Tool (Axial)

1980 First Simple Automated System Commissioned

1985 DRESSER PUMP DRESSER *Pacific & Worthington merge*

1992 Pump Divisions of Ingersoll-Rand & Dresser form joint venture Ingersoll-Dresser Pumps

1994 First 4000 psi (27600 kPa) Jet pump

1995 On Deck Remote System Commissioned

2000 FLOWSERVE *acquires IDP*

2004 First Autoshift ™ Cutting Tool

2008 First 5000 psi (34473 kPa) Jet pump with 6235 psi (42989 kPa) MAWP

2010 Fully Automated System Shipped

2011 Off Deck Remote System Commissioned

2013 Fully Automated System Scheduled for Commissioning

Flowserve has built over 200 coke cutting systems over the past 70 years with drum diameters exceeding 32 ft

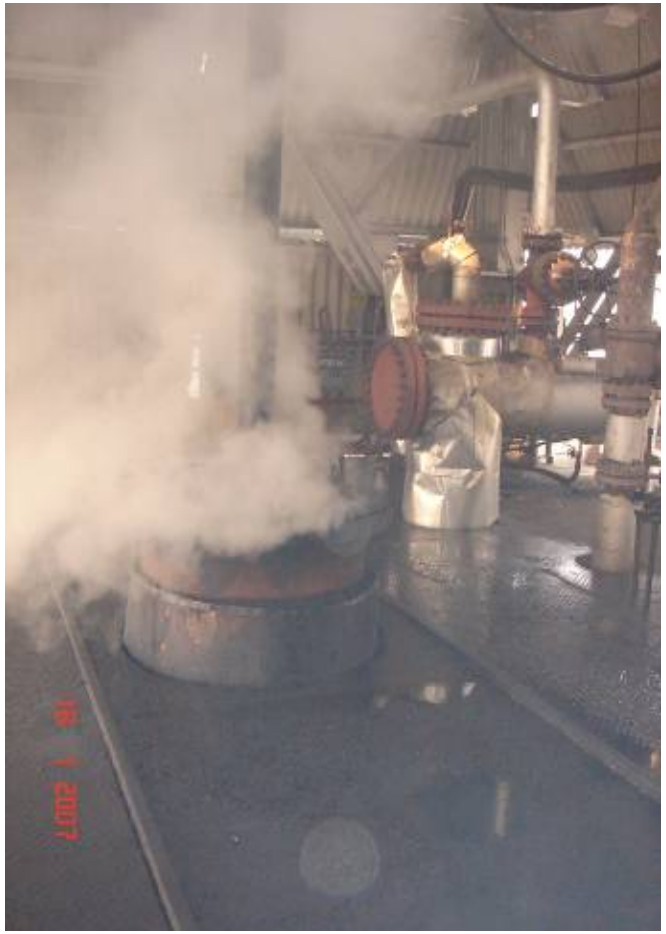
FLOWSERVE®

Coke Cutting Evolution

Hydraulic Coke Cutting Systems History

Manual Cutting – Old systems

- Personnel located on cutting deck
- Operate winch and rotary joint controls



Hydraulic Coke Cutting Systems History

Hydraulic Coke Cutting Systems History

Current Local Cutting Standard Cutting

- Electronic Joystick
- All equipment PLC Controlled
- HMI with full system information

Coke Drum Monitoring

Coke Drum Monitoring

Systems to help operator monitor progress

Audio

Video

Vibration

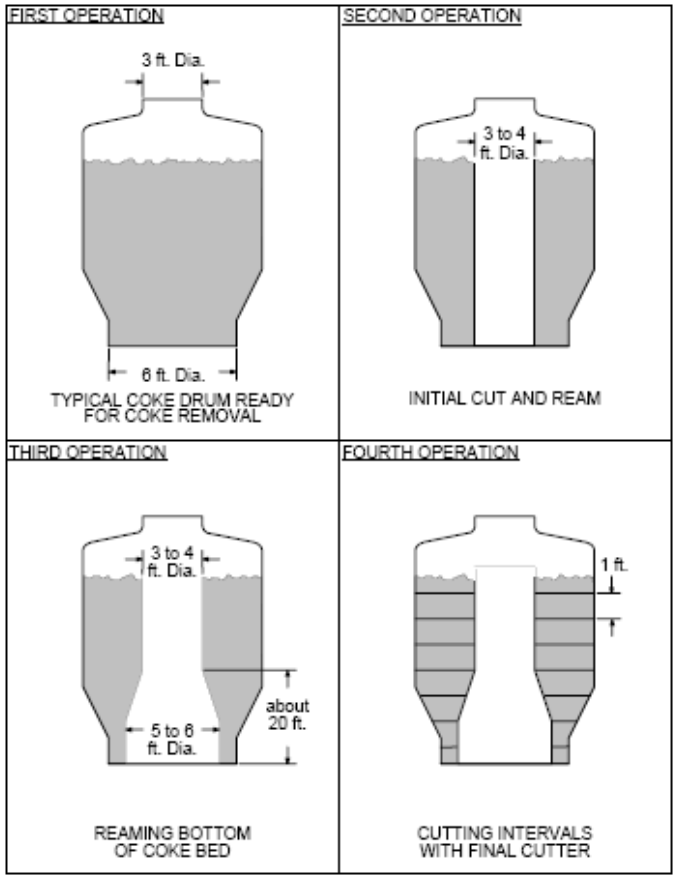
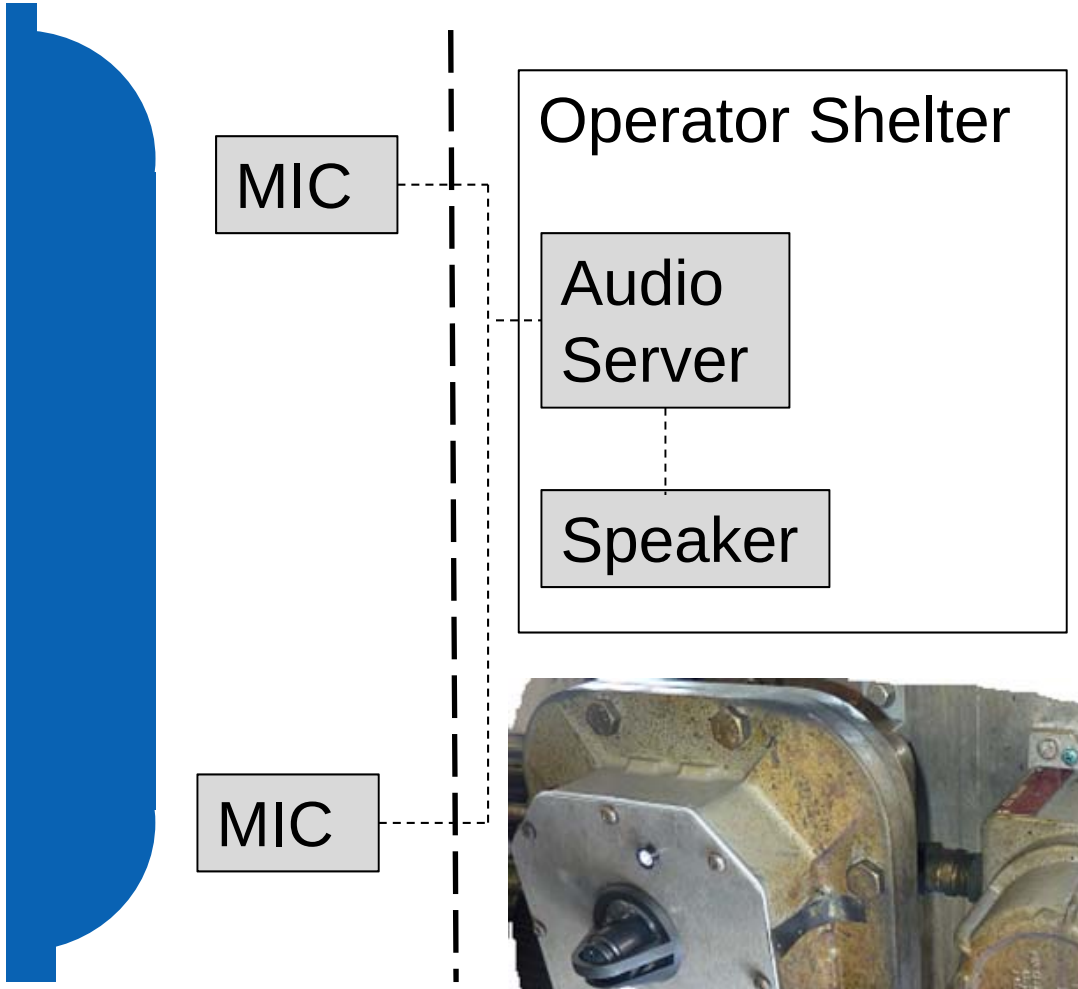


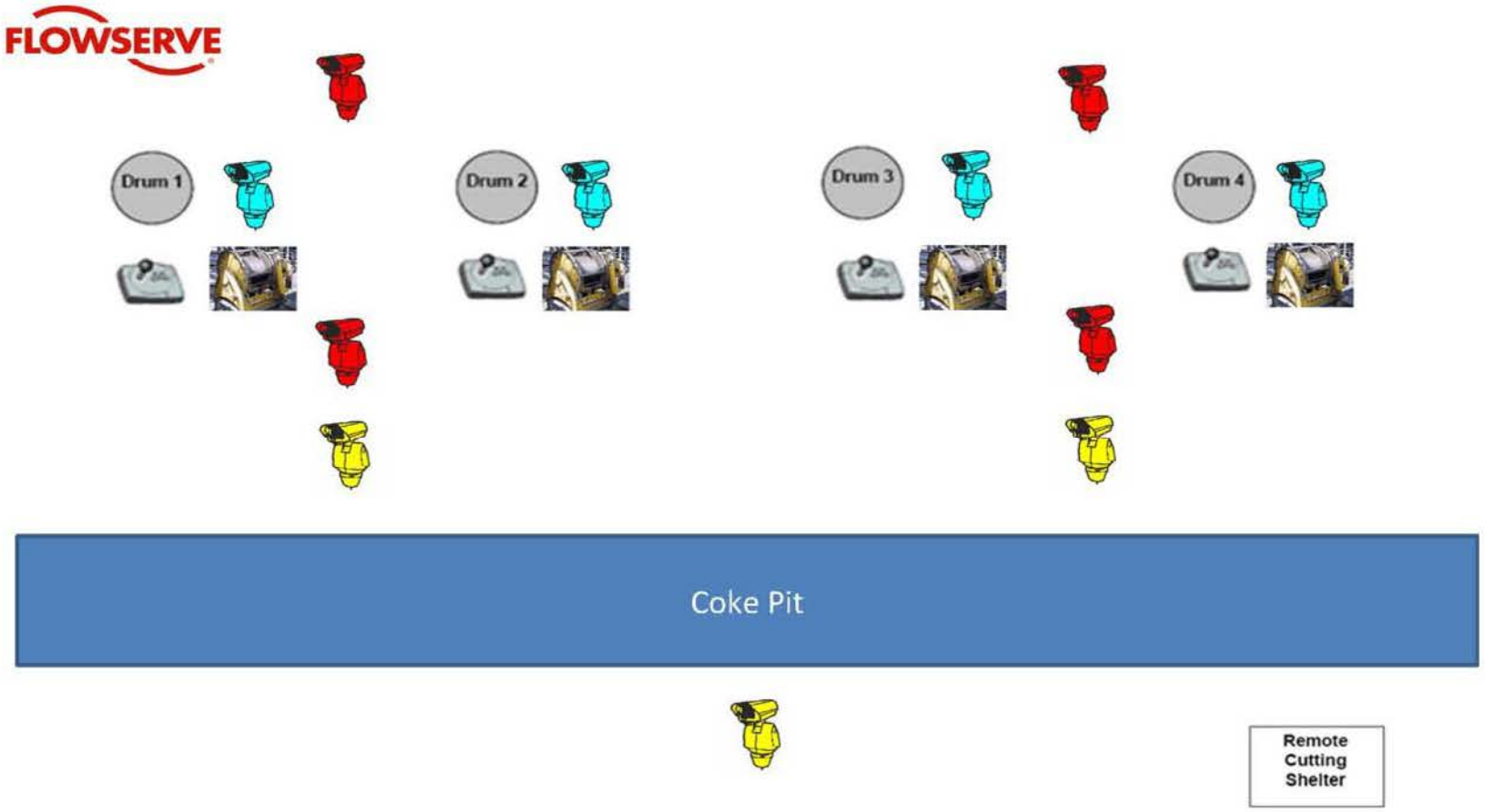
Fig. 2 - Decoking Operation

Coke Cutting Monitoring - Audio



- Allows the operator to hear the jet hit the drum
- More direct than standing at the cutting deck
- Can be routed to on deck or off deck operator shelters

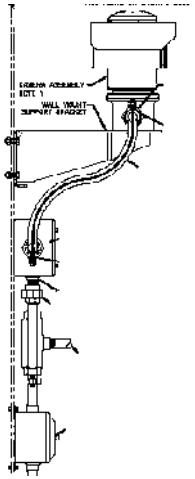
Coke Cutting Monitoring - Video

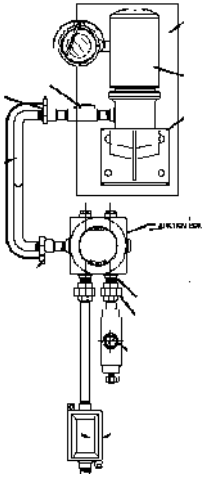


Video Design Considerations

❖ *Flexibility*

- Cameras options
  - Fixed
  - Pan & tilt capability , degrees
  - Zoom capability
  - Infra Red Cameras
  - Weather equipped
    - Lens wiper capable
    - Heater defroster blower
    - De-icing feature





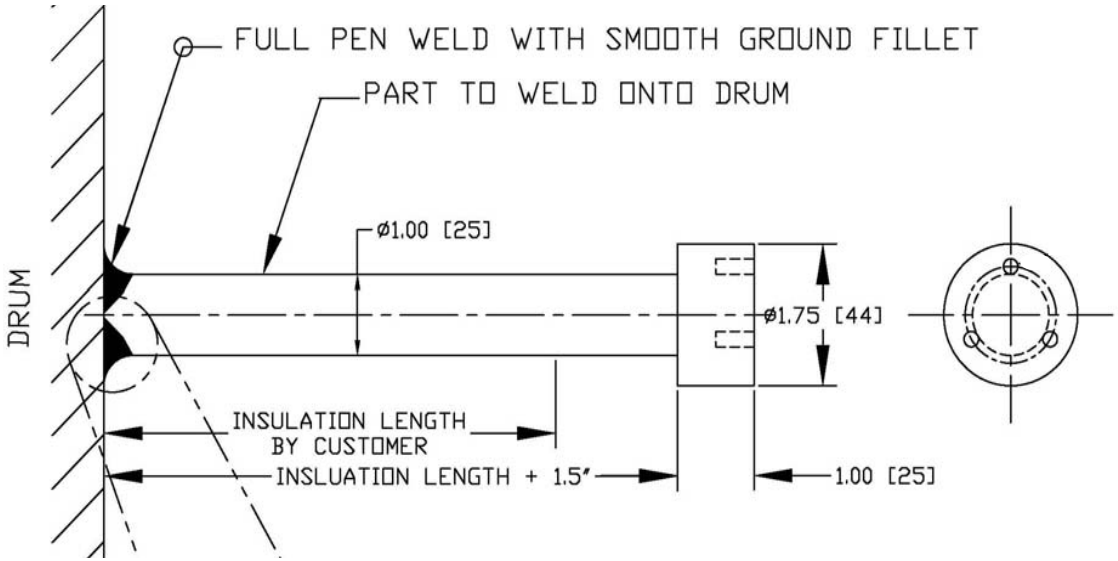
Location in the Delayed Coking Unit

- ***Location of the equipment is key***
  - **Clear field of access**
  - **Protected from outside disruptions**
  - **Adequate utility availability**
    - **Junction box**
    - **Cabling connections**

FLOWSERVE

Coke Cutting Monitoring – Drum Vibration

- *4 Vibration probes mounted on coke drum*
- *Signals routed to Flowserve IPS Apex™ for analysis*
- *Signals displayed on the HMI*

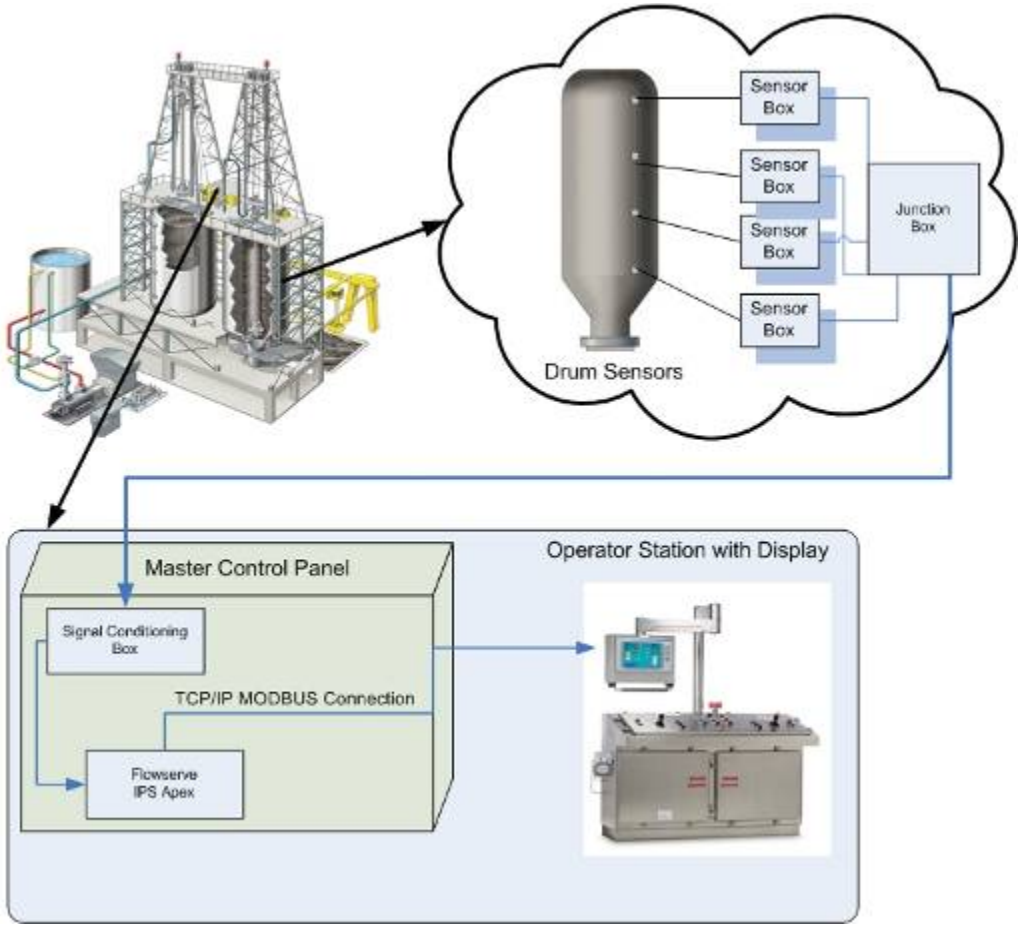


FLOWSERVE

Coke Cutting Monitoring – Drum Vibration

Vibration systems

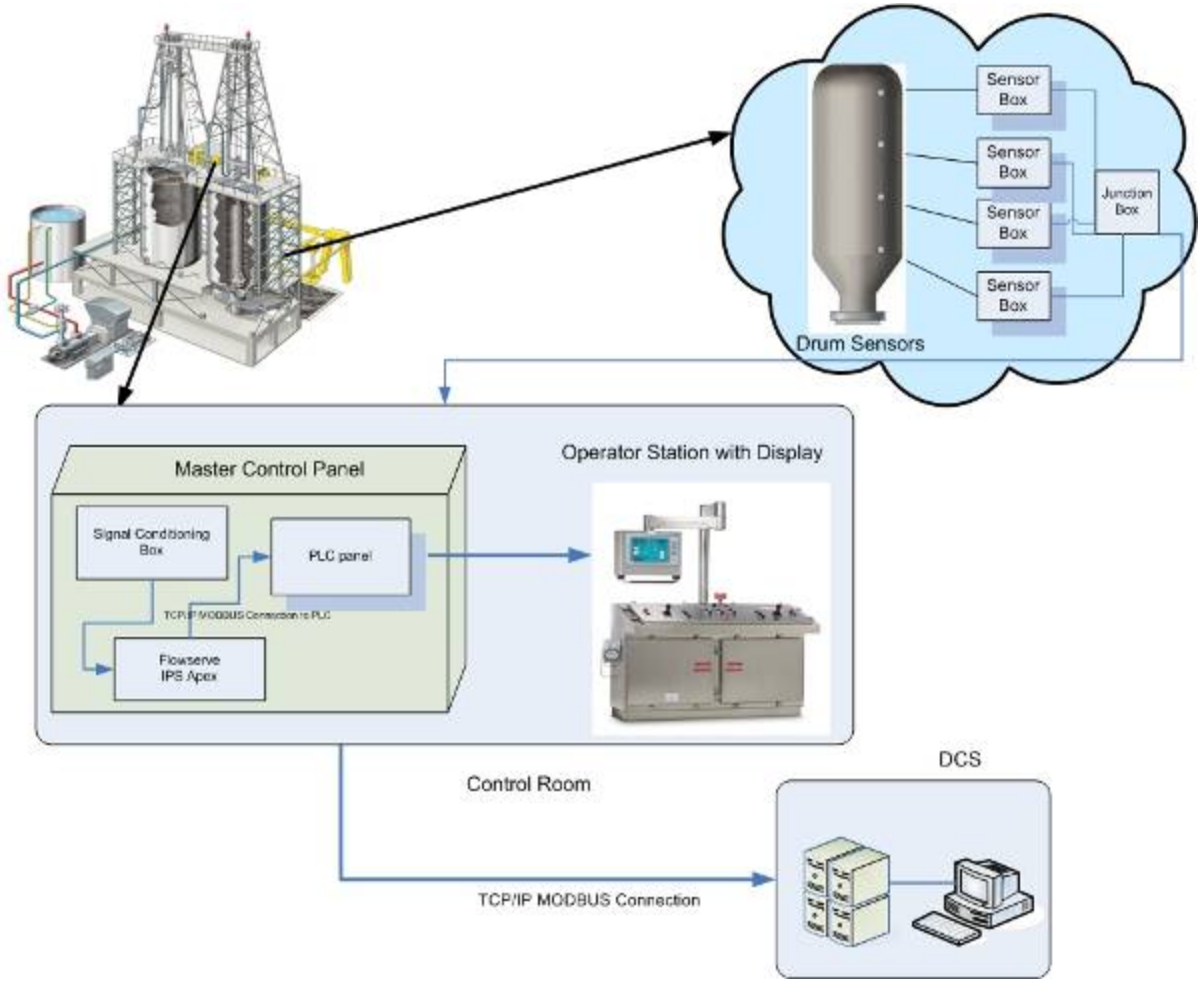
- Signals routed to Flowserve IPS Apex™ for analysis
- Can be displayed on stand-alone HMI or integrated with control system



Coke Cutting Monitoring – Drum Vibration

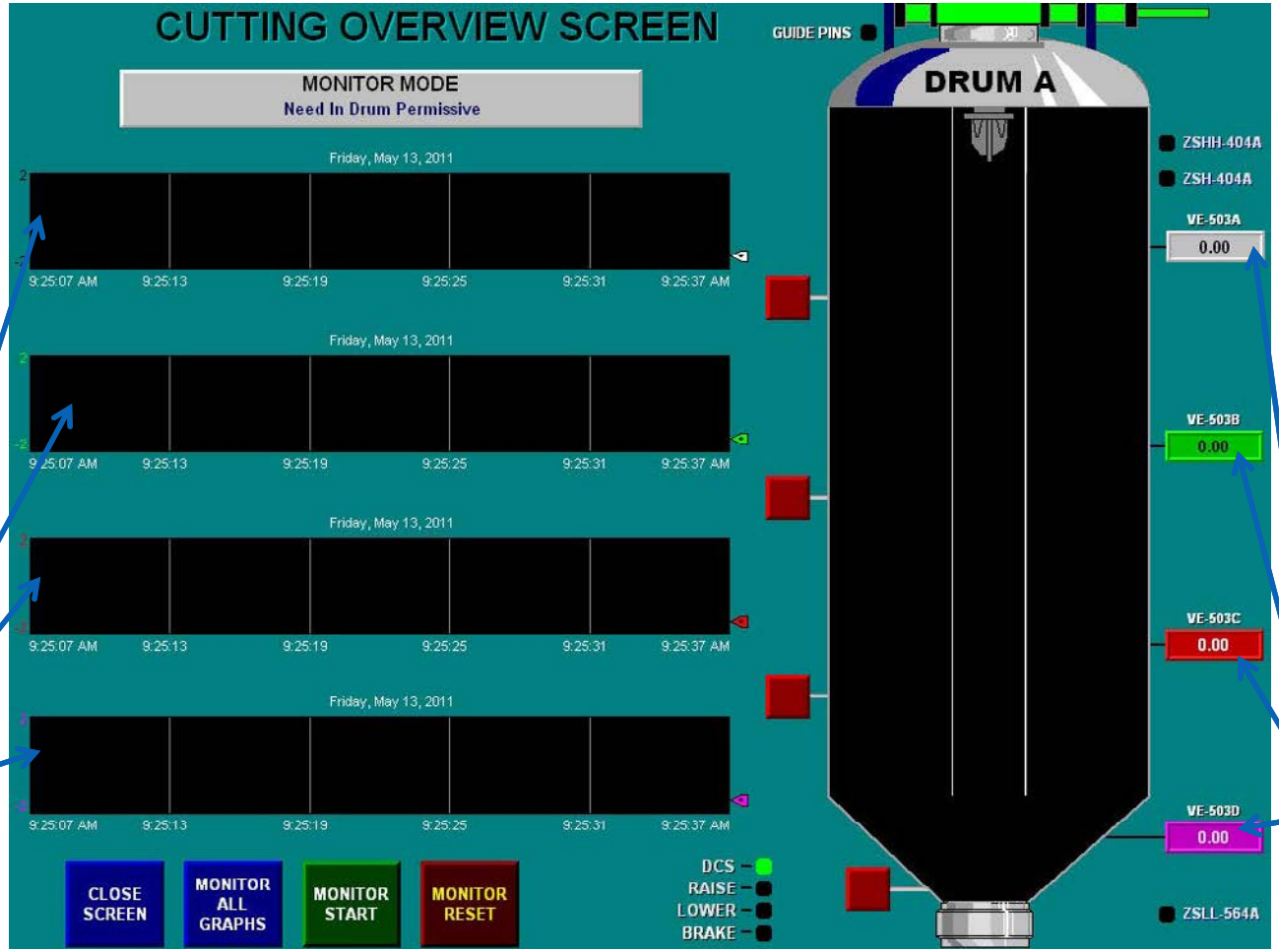
Vibration systems

- Signals routed to Flowserve IPS Apex™ for analysis
- Can be displayed on stand-alone HMI or integrated with control system



Coke Cutting Monitoring – Drum Vibration

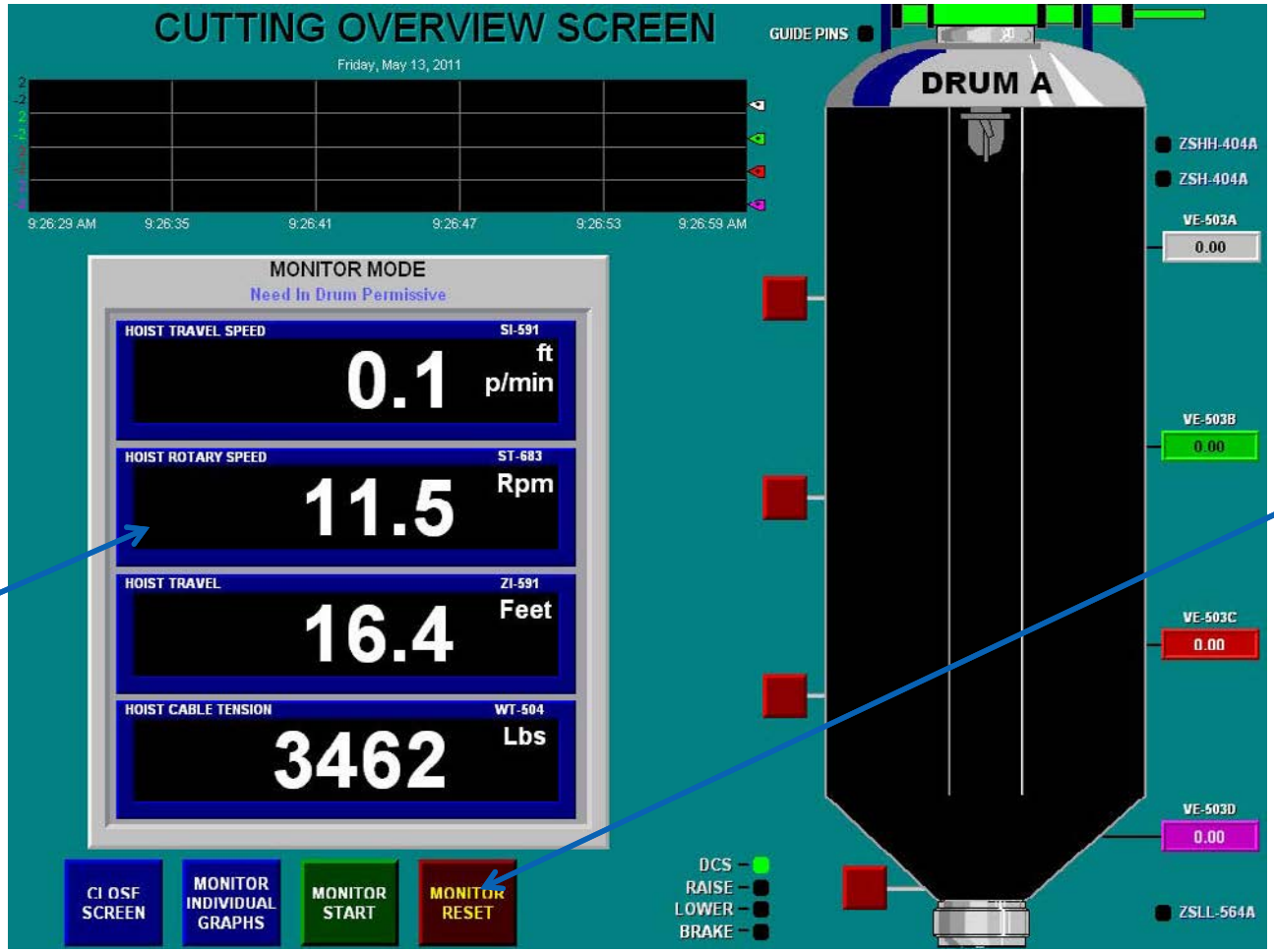
Coke Cutting Monitoring – Drum Vibration



Vibration Strip Charts

Instantaneous Vibrations

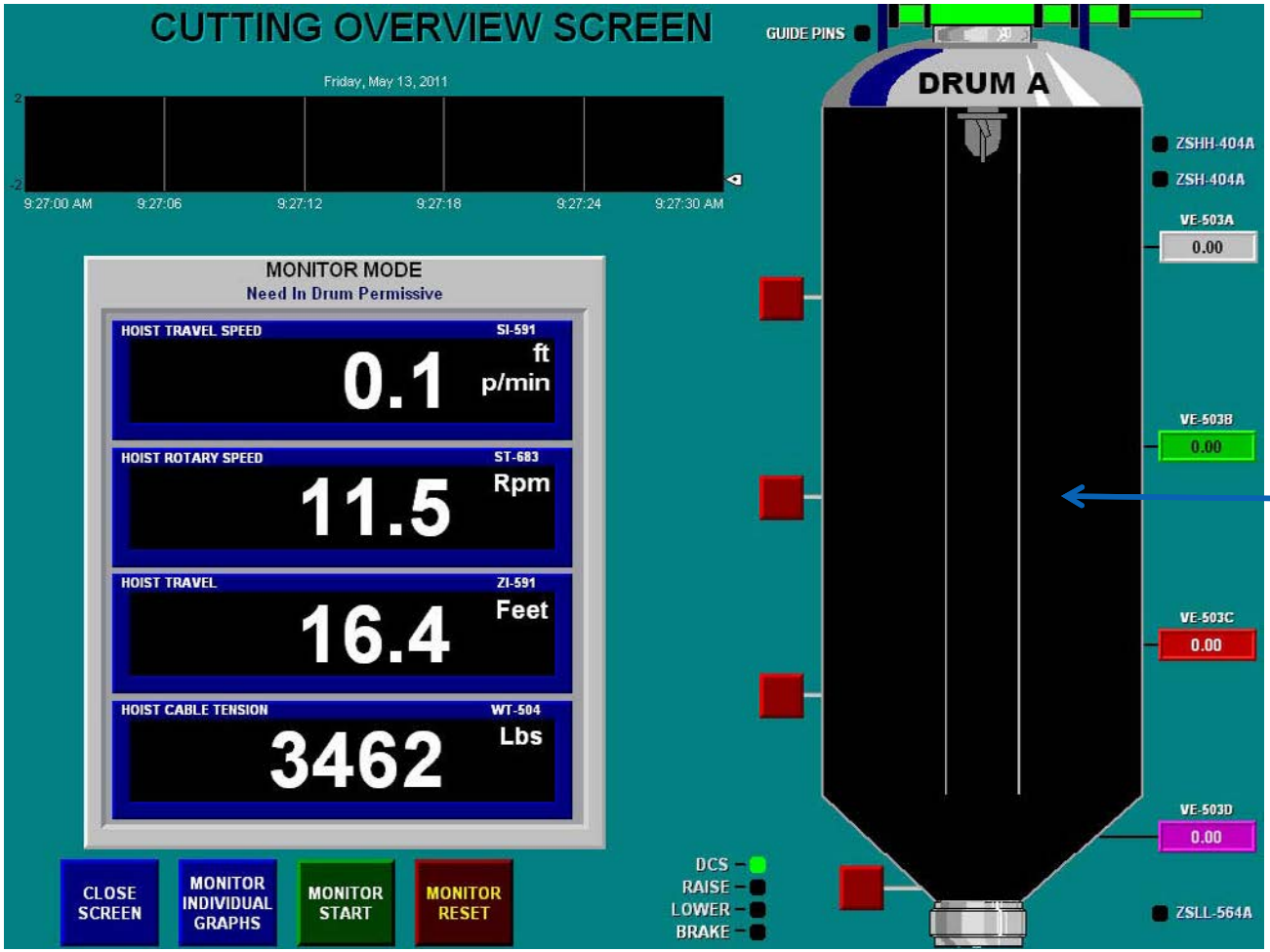
Coke Cutting Monitoring – Drum Vibration



Field Information

Push Button Controls

Coke Cutting Monitoring – Drum Vibration



Drum Cleanliness will be indicated here

2. Remote Coke Cutting

Remote Coke Cutting

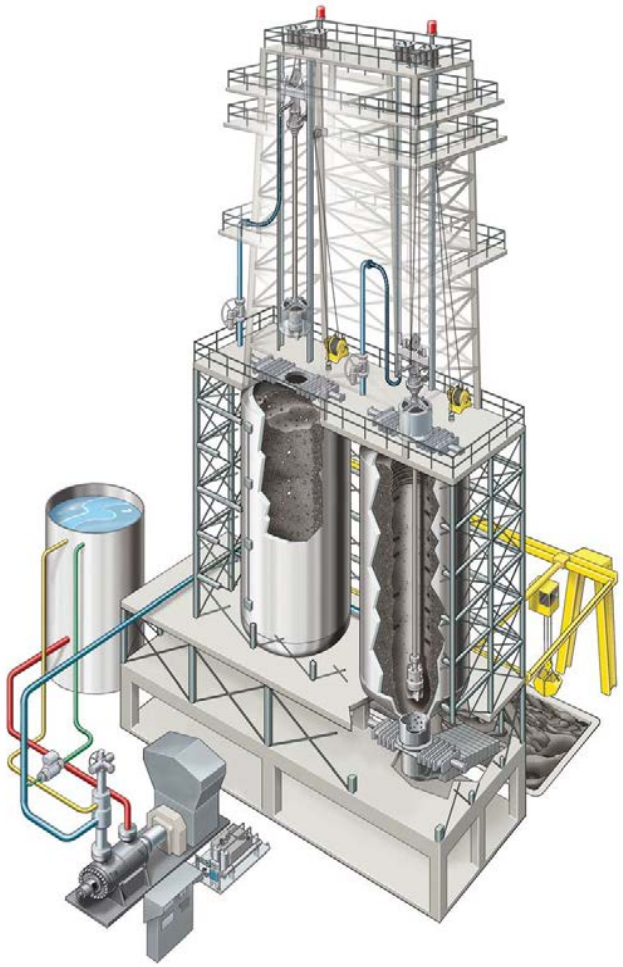
Move operator from the cutting deck to a remote location

Benefits

Increased Safety

Personnel no longer exposed to:

- High-pressure water
- Hot spots or steam eruptions
- Hydrogen sulfide vapors
- Mechanical hazards



FLOWSERVE

Remote Coke Cutting

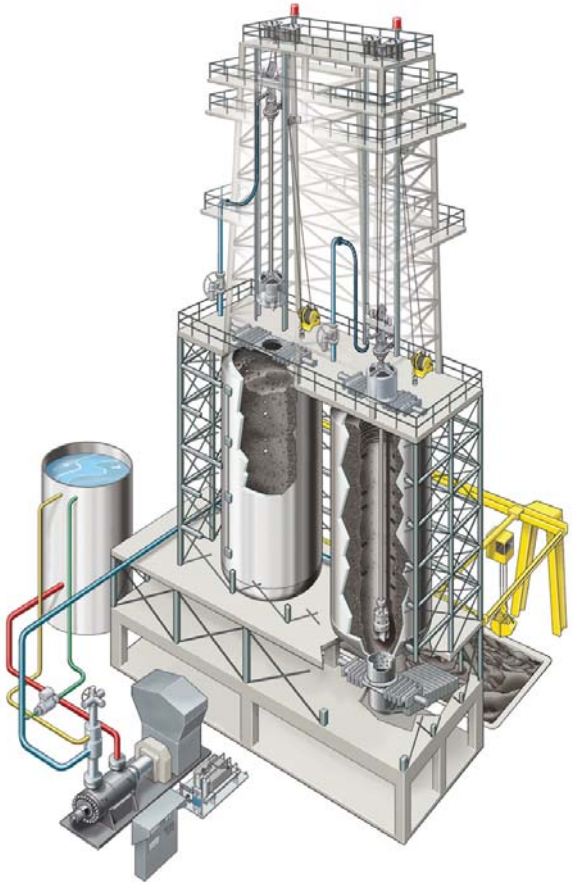
Equipment required

- AutoShift™ cutting tool
- Remote winch and rotary joint operation
- Remote operator enclosure
- Automatic Guide Plate or Tool Enclosure
- Vibration/acoustical devices
- Video equipment

Information required

Data sent remotely to operator

- Cutting tool position and rotational speed
- Cable tension and AutoShift mode
- Drum status
- Video Feedback for Pit, Winch, & Top of Drum



Remote Coke Cutting – First On Deck Site

Modular Cutting Shack Design – Inside

Speaker

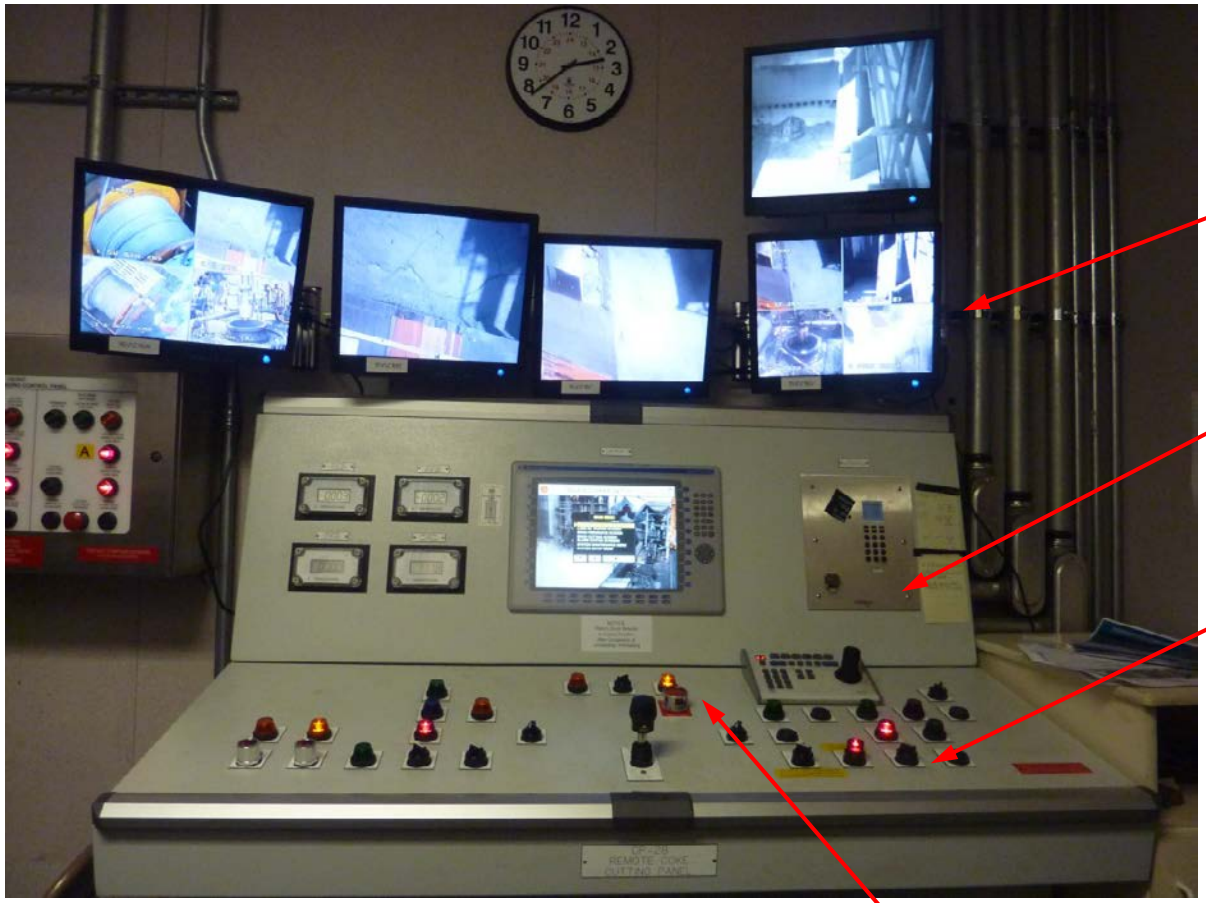
Video camera Display

Coke Cutting Operating Controls

Cutting System Permissives and Operations Status Lights

Photo courtesy M.Moloney, ExxonMobil

Remote Coke Cutting – 2011 Installation



Video camera Display

Speaker

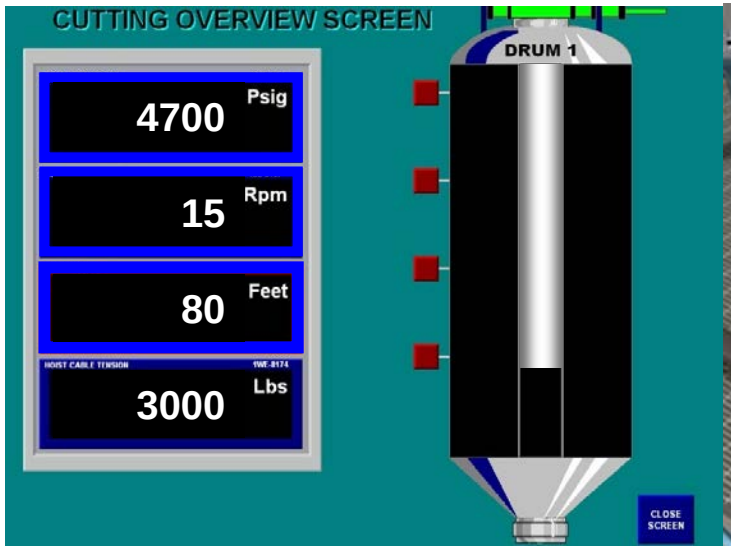
Coke Cutting Operating Controls

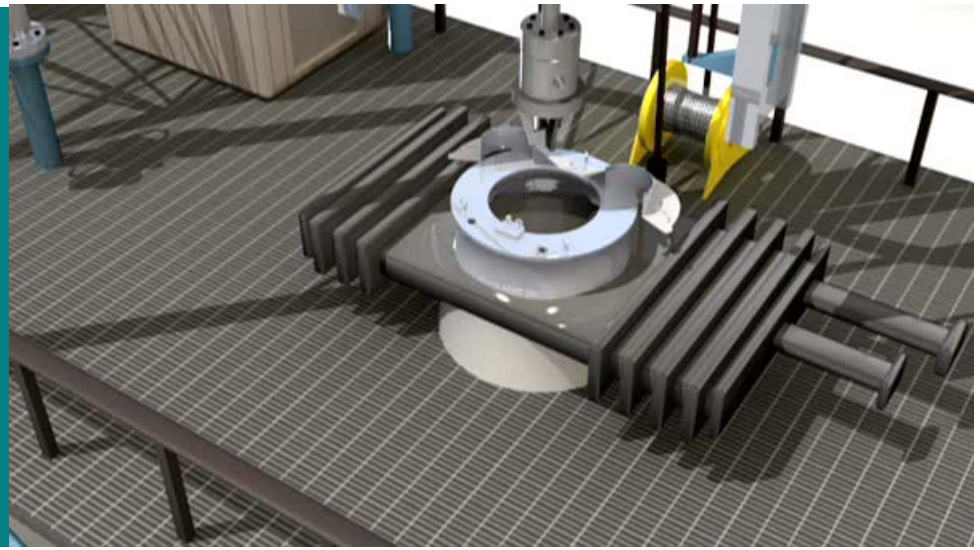
Cutting System Permissives on HMI

Remote Coke Cutting - Boring

Drum Information through Vibration Monitoring
Winch & Rotary Joint Information
System Pressure Information

- *Progress monitored on customizable display screens*

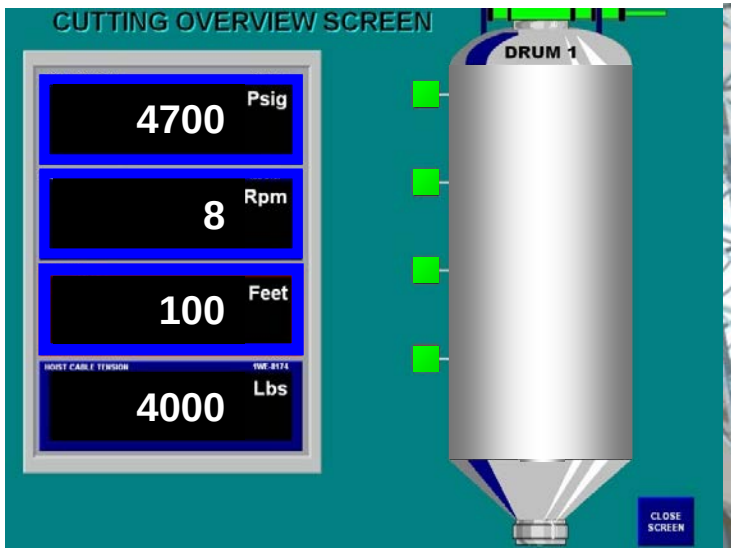




Remote Coke Cutting - Boring

Drum Information through Vibration Monitoring
Winch & Rotary Joint Information
System Pressure Information

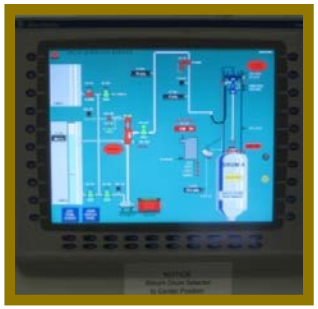
- *Progress monitored on customizable display screens*



Key Learnings & Successful Practices

Video is essential 'kit' for a coke handler. Site requires a system which is reliable and will provide at least four views simultaneously.
(Open head, winch drum, chute, and crane location.)

Consider "serious controls" on human presence on the cutting deck during unheading and decoking. Routine human presence may come to be viewed as necessary, and reduce the benefit of the effort.



HMI graphics need to be simple to use, consistent, and well understood by the coke handler.

FLOWSERVE

Key Learnings & Successful Practices

Consider hydraulic or electric winches.

Take care in arranging commissioning activities and resources, especially if remote decoking is being commissioned in conjunction with other complex changes. Missing a step or double-booking a resource can easily cost you hours or days.

FLOWSERVE

Automated Coke Cutting

Automated Coke Cutting

History

- *1980s – Simple Boring & Time Based Cutting*
- *mid 2000's – BP Gelsenkirchen – On deck, time based, with some vibration feedback*
- *2010 - Fully automated systems*
  - *Embedded intelligence and advanced algorithms to process signals and control the cutting process*
  - *Automatic coke cutting with continuous feedback*
  - *Operator consulting only required for exceptions*

Automated Coke Cutting- Equipment

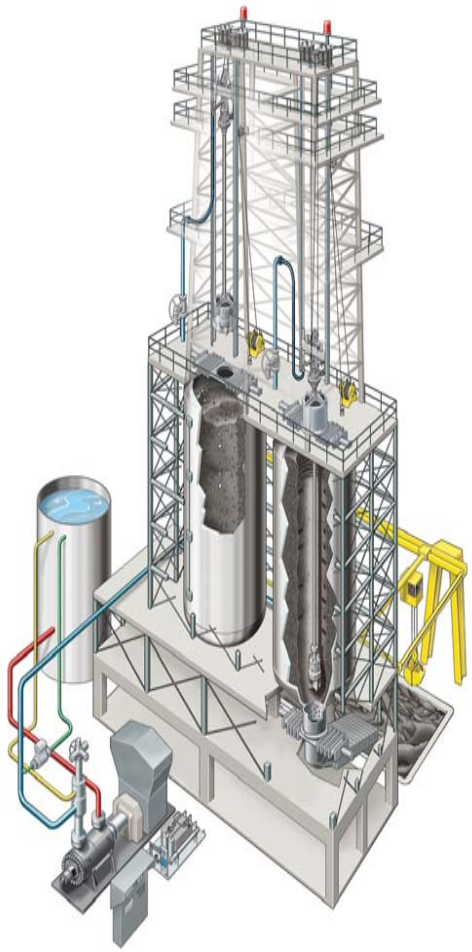
PLC cuts coke. Operator needed for abnormalities

Equipment required

- AutoShift™ cutting tool
- Remote winch and rotary joint operation
- Remote operator enclosure
- Automatic Guide Plate or Tool Enclosure
- Vibration Drum Monitoring

Information required

- Data received by PLC and transferred to IPS APEX
  - Cutting tool position and rotational speed
  - Cable tension and AutoShift mode
- Data received directly by IPS APEX
  - Drum status



FLOWSERVE

Automated Coke Cutting

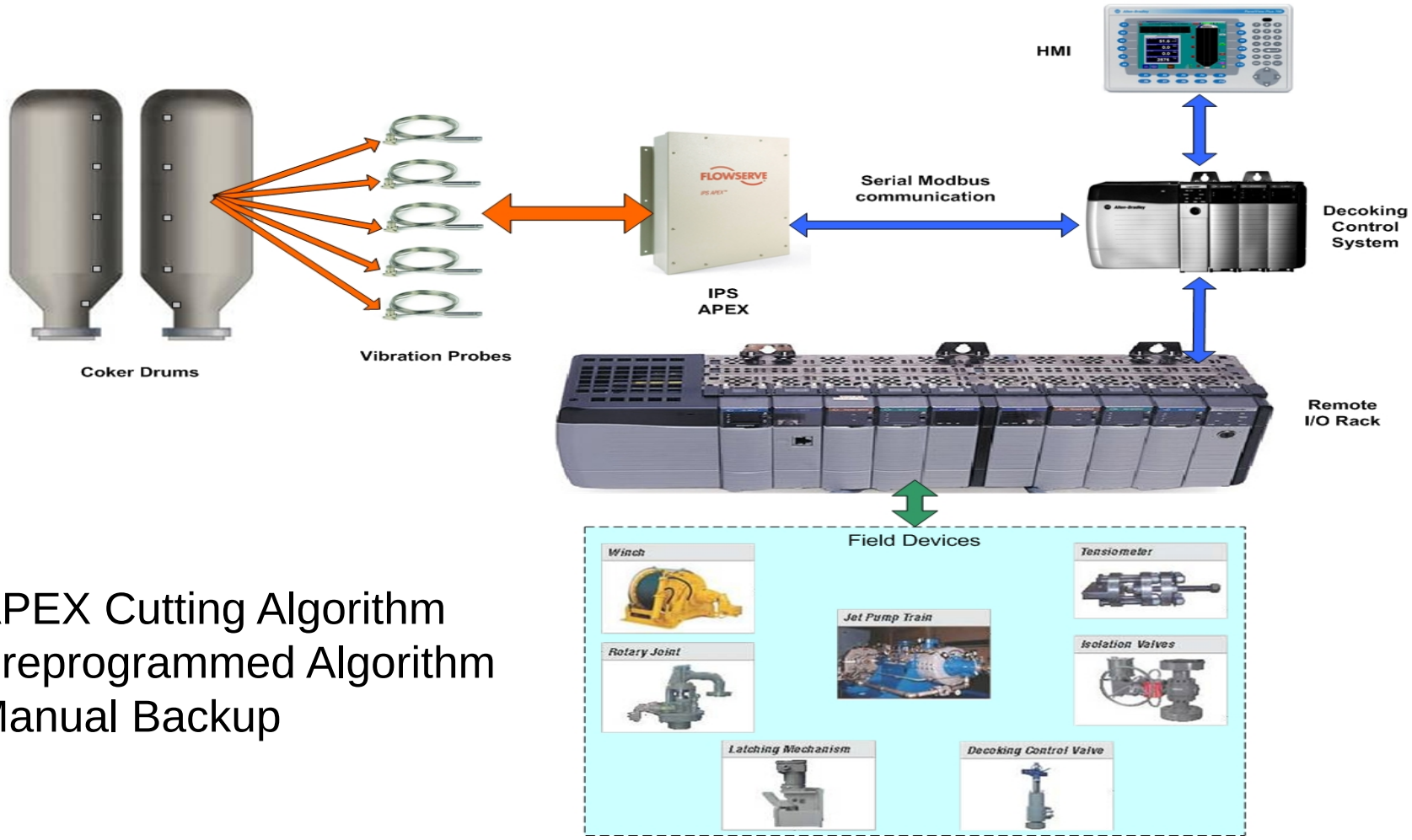
Basic operation

Use vibration sensors mounted on the coke drum to provide feedback on the state of cleanliness of the drum wall

Sensors provide interactive feedback on the cutting status that can optimize the cutting time

Program is customized based on site-specific cutting practices and configured with end user

Automated Coke Cutting



- APEX Cutting Algorithm
- Preprogrammed Algorithm
- Manual Backup

Automated Coke Cutting- Benefits

Improved cutting personnel safety

- Automated cutting system integrated with PLC interlocks
- Minimize probability of operator mistake
- Eliminates shortcuts sometimes taken by cutting personnel
- Standardized cutting procedures reduce risk of aggressive cutting practices

Process efficiency and consistency

- Advance the cutting program as soon as possible based on vibration feedback
- Consistent cutting times with standardized cutting procedure

FLOWSERVE

Automated Coke Cutting- Benefits

Improved equipment reliability

- Less damage from ramming tool into coke bed during boring
- Less chance of damage from aggressive cutting techniques
- Can monitor performance of jet pump and other decoking equipment for predictive maintenance

Data recording for process optimization / troubleshooting

- Data recorded and can be compared w/process data to optimize cycle times
- Ability to access data for troubleshooting in case of any failure event
- Ability to monitor performance of jet pump and other decoking equipment for predictive maintenance

FLOWSERVE

Remote & Automated Coke Cutting

Thank You

Andrew Worley
aworley@flowserve.com