



# Remote and Automated Decoking Systems



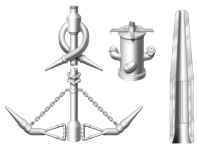
*Experience In Motion*





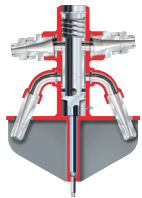
## Advancing safety, availability and profitability

Through its Worthington®, Pacific® and IDP® heritage brands, Flowserve has played a leading role in hydraulic decoking since the technology's inception more than three-quarters of a century ago. From the original combination cutting tools and jet pumps to today's state-of-the-art remotely operated and fully automated systems, Flowserve is the overwhelming supplier of choice for coke cutting systems, with more than 200 installations globally, comprising over 90% of the world's units. Process licensors, engineering, procurement and construction (EPC) firms and delayed coker unit (DCU) operators alike turn to Flowserve for its proven applications expertise and problem-solving capabilities.



Flowserve Worthington supplies the cutting tools, swivel joints, control valves and jet pumps for the world's first hydraulic decoking installation at Shell Oil's Wood River, Illinois, (USA) refinery.

**1938**



Flowserve Pacific introduces the "combo" design — an axially shifted combination tool incorporating both boring and cutting nozzles within a single body.

**1979**



Flowserve installs first hydraulic motor-driven winch and rotary joint combination.

**1994**

Proprietary AutoShift™ technology installed on rotary actuated, remotely shifted Combination tool opens the door to cutting system automation.

**2003**

Flowserve installs electric motor-driven winch and rotary joint with variable frequency drive (VFD) control.

**2008**



Flowserve designs and ships the first fully automated coke cutting system with coker-specific designs for audio and video monitoring.

**2011**

**1940**

Flowserve Pacific supplies hydraulic decoking jet pumps at Standard Oil's El Dorado, Kansas, (USA) refinery.

**1981**

Flowserve Pacific introduces the decoking control valve that ensures the jet pump is never in a blocked condition.

**1998**

The need for higher pressure systems with increased efficiency results in the rotary shifted combination tool.

**2004**

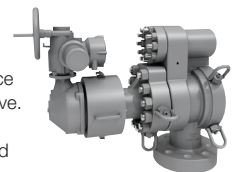
Flowserve equips the first remotely operated cutting system. Vibration drum monitoring is introduced.

**2010**

Vibration drum monitoring is updated with improved operator feedback.

**2013**

Flowserve releases advanced decoking control valve to replace the Pacific decoking control valve. The new valve improves mean time between repair (MTBR) and field maintainability.







## Continuing to innovate: Remote and automated operation

Flowserve has pioneered numerous significant advancements in decoking, transforming it into an increasingly safe, efficient and automated process.

Improving personnel safety has always been the number one goal of DCU managers. Removing operators from the cutting deck would eliminate their exposure to inherent decoking dangers, including:

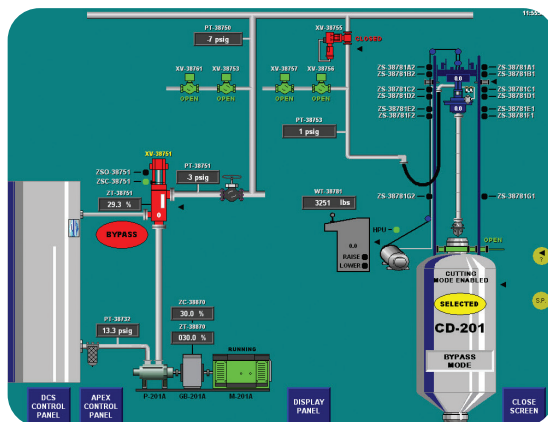
- High-pressure water
- Hot spot steam eruptions
- Hydrogen sulfide (H<sub>2</sub>S) vapors
- Fire and mechanical hazards

The introduction of drum monitoring through vibration and the Combination cutting tool with AutoShift, along with significant advancements in associated equipment design, now make remote operation possible. The addition of modern instrumentation, controls and software technology can achieve system automation for reduced cutting times with greater throughput, maximum reliability and lowest total cost of ownership.



*With manual mode shifting, personnel may be exposed to hazards at the drumhead.*

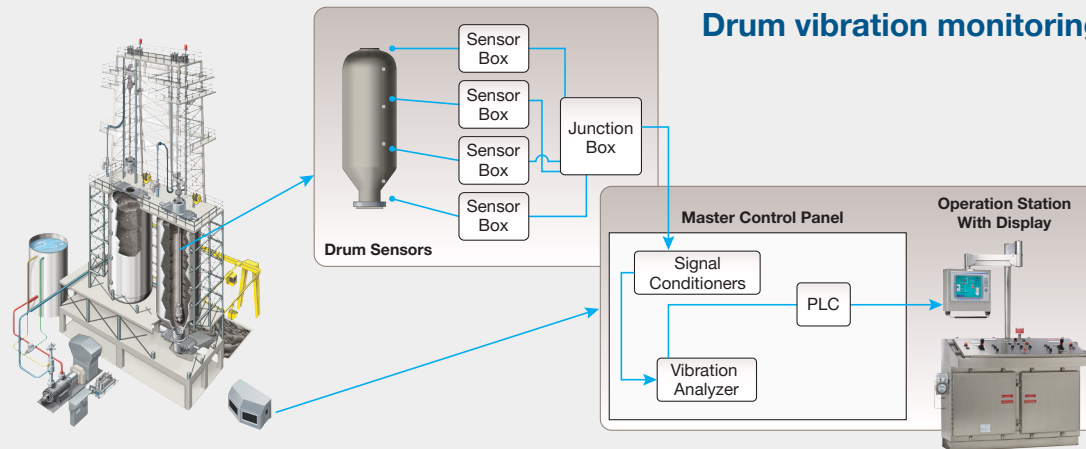
*Remote and automated systems eliminate these risks.*







## Drum vibration monitoring schematic



## Drum monitoring systems

Vibration, acoustic and video drum monitoring devices inform operators of cutting progress, while enabling them to see and hear cutting deck, chute and pit activities.

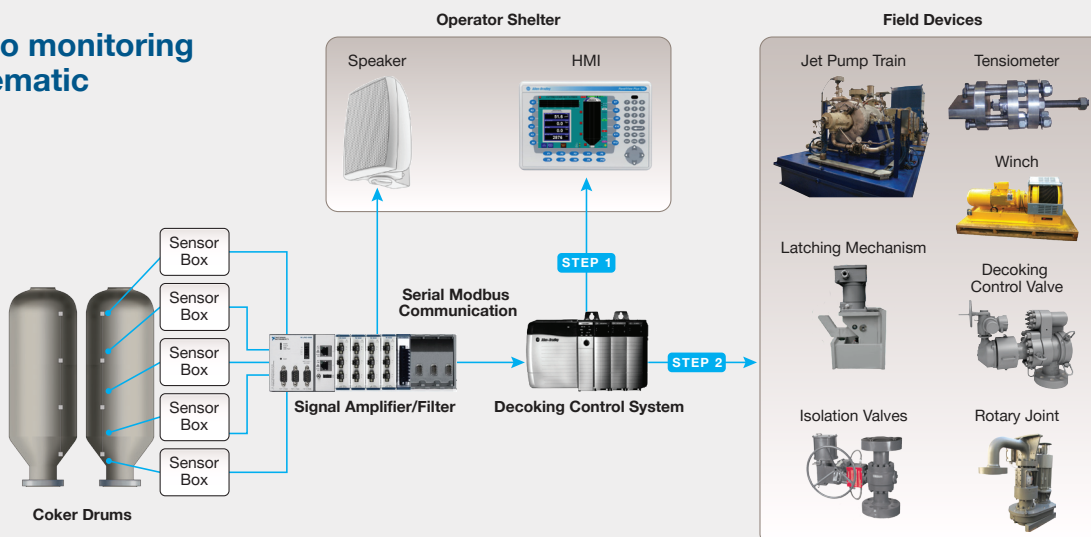
### Drum vibration monitoring

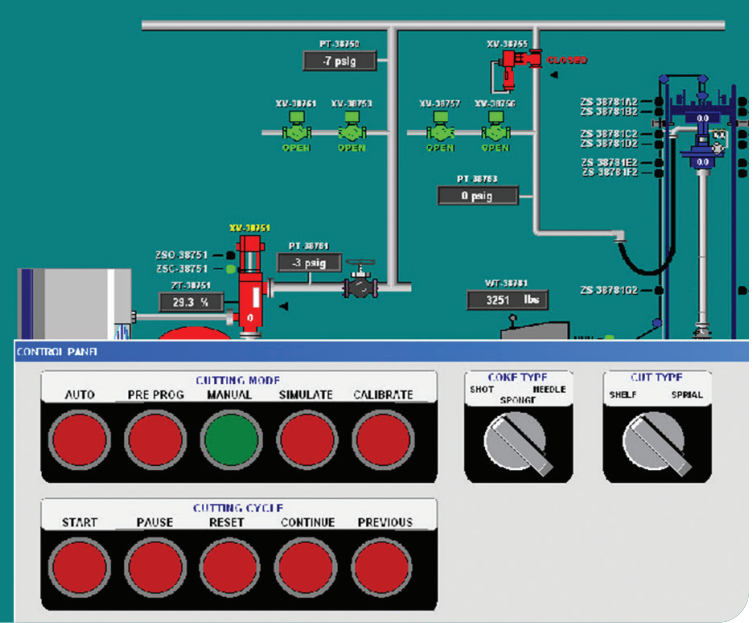
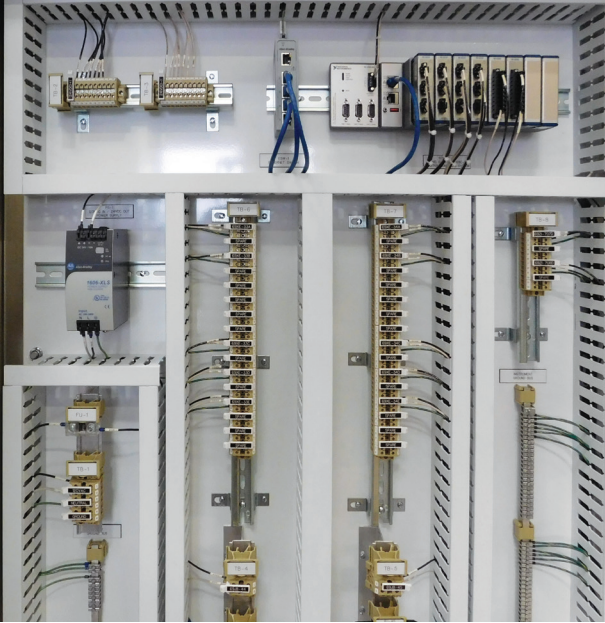
A key element in remote system operation is establishing with certainty the position of the tool within the drum during the cutting process. High-temperature vibration probes monitor drum wall vibration to determine tool location and coke-cutting states. The information is relayed to the operator's control panel in the remote operating shelter.

## Audio and video drum monitoring

Feedback on cutting progress and activities is enhanced by acoustic and video systems designed to help the operator determine the progress of coke removal. As coke is cut from the drum, the sound of the impinging water changes, thus allowing the operator to "hear" when a section of the drum is clean. Simultaneously, a video monitoring system enables the operator to view the cutting deck, winch, cutting tool assembly, coke chute and pit, all from the safety of the remote shelter. Cutting mechanism problems can be quickly addressed, while chute and pit observations confirm when coke removal is complete for each cutting step.

## Audio monitoring schematic





## Coke cutting automation

### Next level reliability and productivity

Flowserve automated decoking technology combines the capabilities of its remotely operated cutting equipment and drum monitoring systems with embedded intelligence and advanced algorithms to control the cutting process. Controlled by the PLC, operator intervention is only required in the event of sequence exceptions. The preprogrammed cutting operations are customized to minimize cycle times while maximizing safety and reliability. The result is safer, faster, more efficient coke cutting.

### Automation benefits

#### Improved personnel safety

- Automated cutting system with integrated PLC interlocks minimizes the probability of operator error and eliminates potentially hazardous shortcuts.
- Standardized cutting procedures reduce risk of aggressive cutting practices.

#### Improved equipment reliability

- Intelligently monitors condition/controls of critical cutting equipment
- Provides diagnostics for preventive maintenance to extend MTBR intervals and increase equipment life

#### Improved process efficiency and consistency

- Optimizes cycle times by advancing program and cutting tool as soon as possible
- Achieves consistent cutting times with standardized cutting procedures

#### Data recording for process optimization or troubleshooting

### Advanced control with intelligent automation

Automated decoking is made possible with the advanced monitoring, diagnostics, control and instrumentation capabilities built into the PLC and data acquisition system. Flowserve will custom design and commission the requisite computer software and algorithms, instrumentation and embedded intelligence to automatically operate the decoking system while protecting it from unanticipated downtime.

### Automation system capabilities

In addition to our intelligent control technology, Flowserve can provide all the equipment necessary for DCU cutting automation, including:

- Slim Combination cutting tool with AutoShift
- Remotely operated winch, rotary joint and unheading valves
- Automatic guide plate and tool enclosure
- Drum vibration monitors to determine tool position and cutting progress
- Cutting equipment sensors to monitor tool rotational speed, wire rope system tension, etc.
- Interlocked safety systems for cutting water flow control
- Remote operator enclosure with master control panel
- Video and acoustic equipment to observe cutting deck activities, as well as coke chute and pit status



## Coke cutting system upgrades and services

Most Flowserve decoking units installed after 2005 can be upgraded easily to remotely operated or automated systems by adding drum monitoring instrumentation and equipment. Older systems require a customized and comprehensive review to identify the most cost-effective safety and performance upgrades.

Regardless of original equipment manufacturer (OEM), Flowserve offers replacement of vintage decoking equipment with all-new or significantly redesigned models, including:

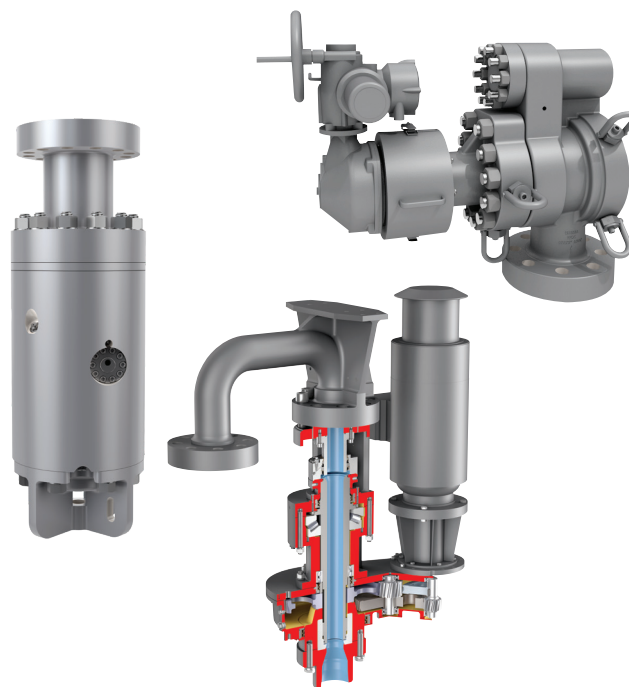
- Cutting tool
- Decoking control valve
- Rotary joint
- Jet pump
- Control system

### Upgrade experts

A global network of Flowserve decoking specialists will help evaluate and specify the equipment and components required to upgrade an existing coke cutting operation into the most cost-effective, state-of-the-art remotely operated or automated system possible.

With improved safety and efficiency as goals, the Flowserve decoking specialists will:

- Assess each component of the system for proper functionality
- Audit the control system for hardware and software technology improvements
- Analyze the unit's structural and civil integrity, including the decoking tower
- Provide recommendations and action steps for system conversion



### Field service and technical support

Flowserve customer service technicians are on call 24 hours a day, seven days a week to respond to scheduled or unscheduled outages, construction, installation and start-up service needs. Technicians are specifically trained to evaluate and troubleshoot problems with decoking systems and equipment. Backed by Flowserve design and engineering groups, technicians have access to manufacturing drawings, bills of material and performance data so they can develop practical and reliable solutions to decoking problems.





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