

# Blowout Preventer Stack and Control Systems

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- What is a Blowout preventer and why is it important?
- How and when is a Blowout Preventer installed?
- Basic design and operating principles
- BOP control systems
- BOP limitations and reliability

What is a Blowout Preventer and why is it important?



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## What is a Blowout Preventer and why is it important?

- A mechanical device to seal the top of the well (a secondary means of well control)
- Once sealed, it allows access to the wellbore below the BOP to control the well
- The installation of a BOP is a normal regulatory requirement
- The installation of a BOP is a common insurance warranty
- The BOP is of fundamental importance to the EED 886 definition of a well out of control

## WARRANTIES

*It is warranted that where the Assured is the operator or joint operator on any insured well being drilled, deepened, serviced, worked over, completed and/or reconditioned, **a blowout preventer(s) of standard make will**, when in accordance with all regulations, requirements and normal and customary practices in the industry, **be set on surface casing or on the wellhead and installed and tested in accordance with usual practice.***

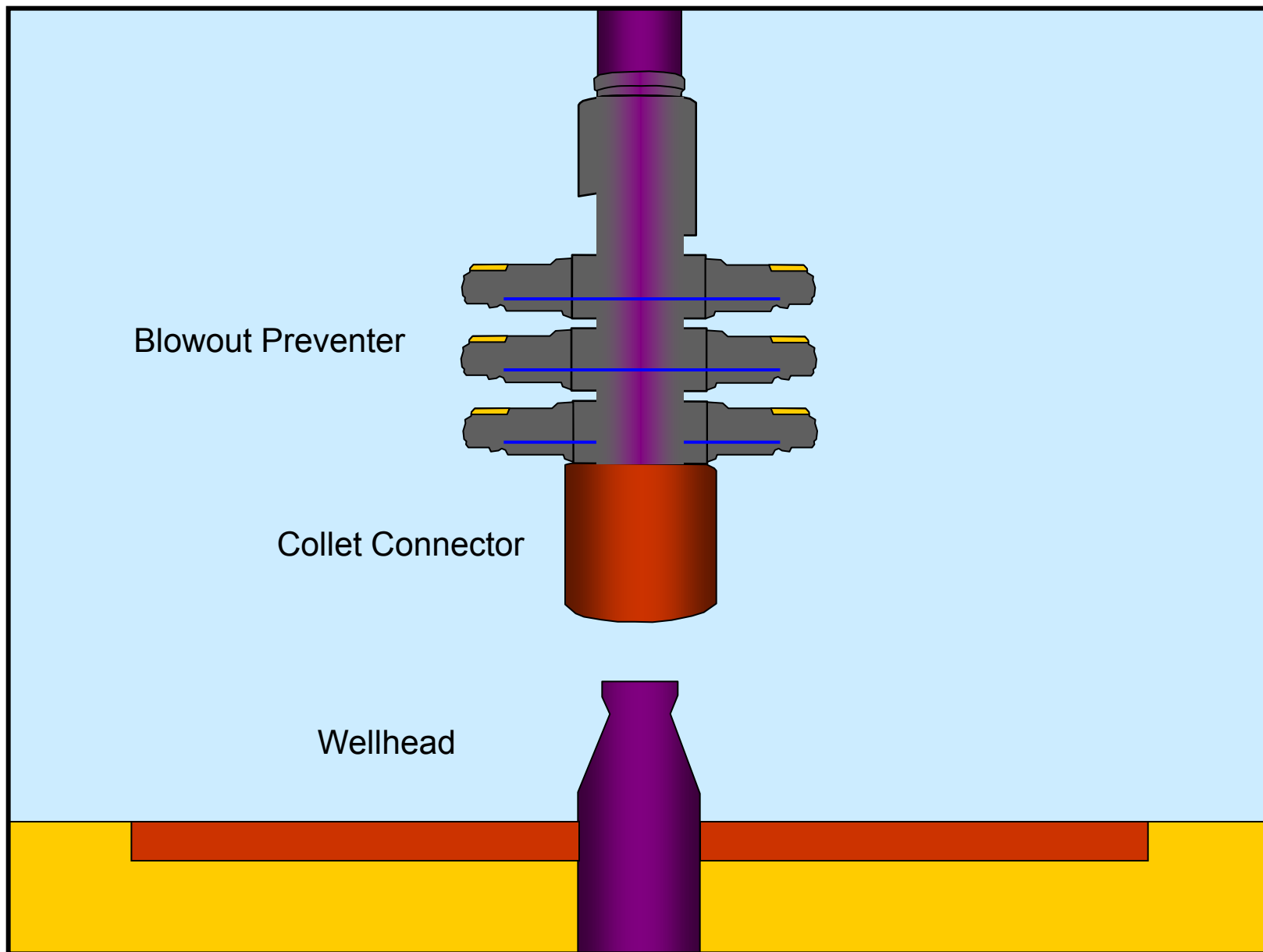
## WELL OUT OF CONTROL DEFINITION

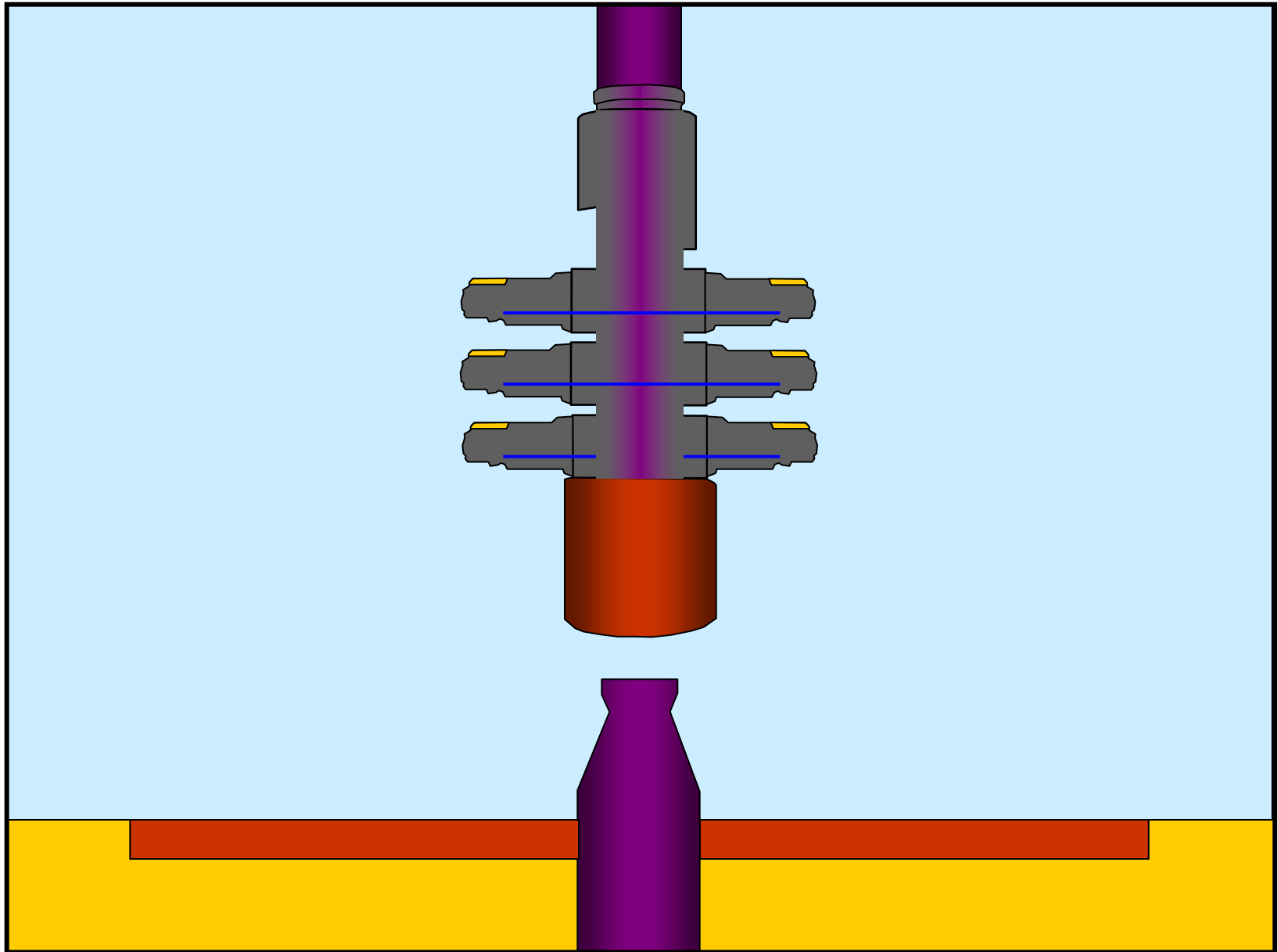
*“...a well(s) shall be deemed to be out of control only when there is an unintended flow from the well(s) of drilling fluid, oil, gas or water above the surface of the ground or water bottom,*

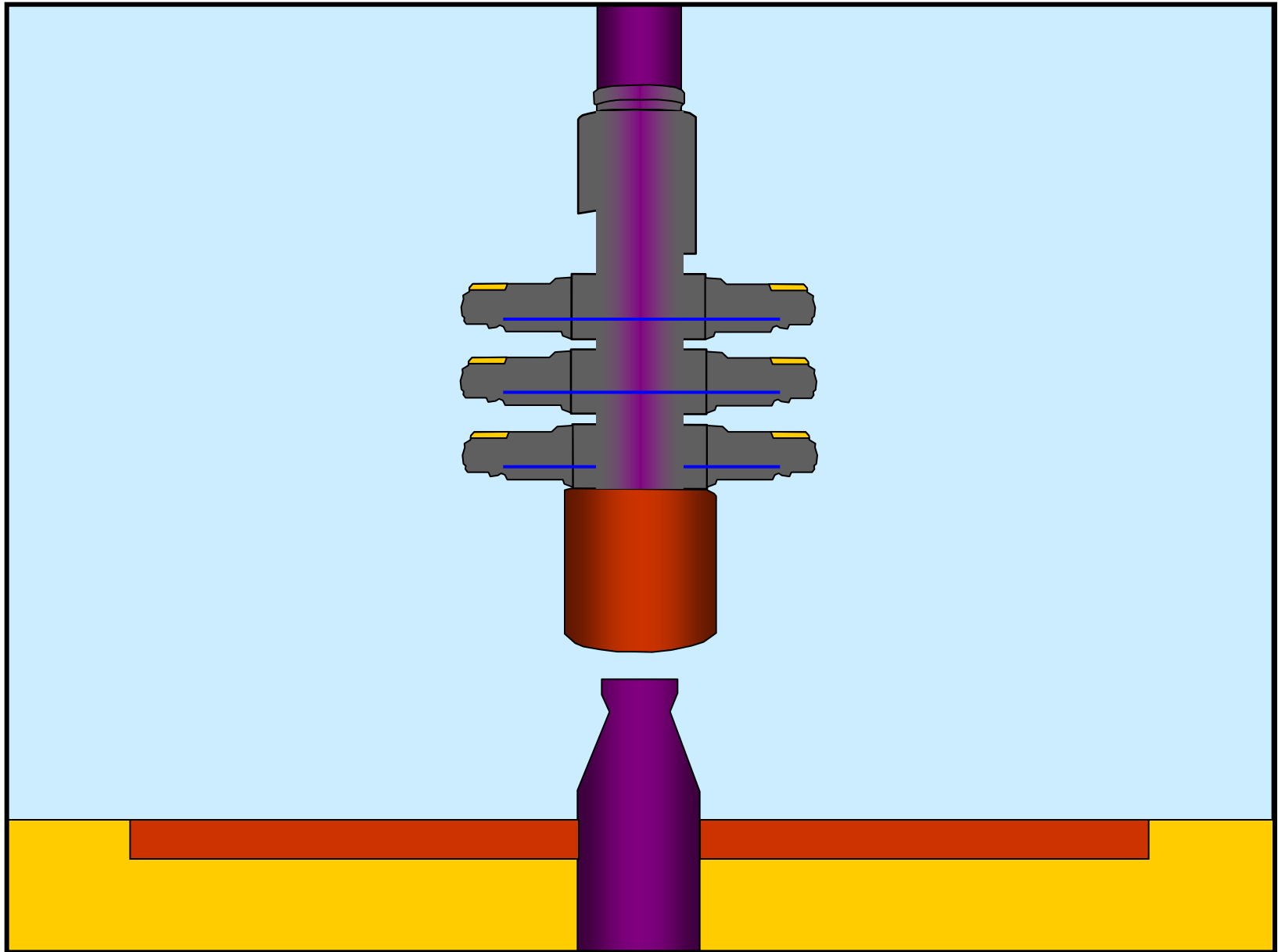
*which flow cannot promptly be...stopped **by use of the equipment on site and/or the blowout preventer, storm chokes or other equipment ...”***

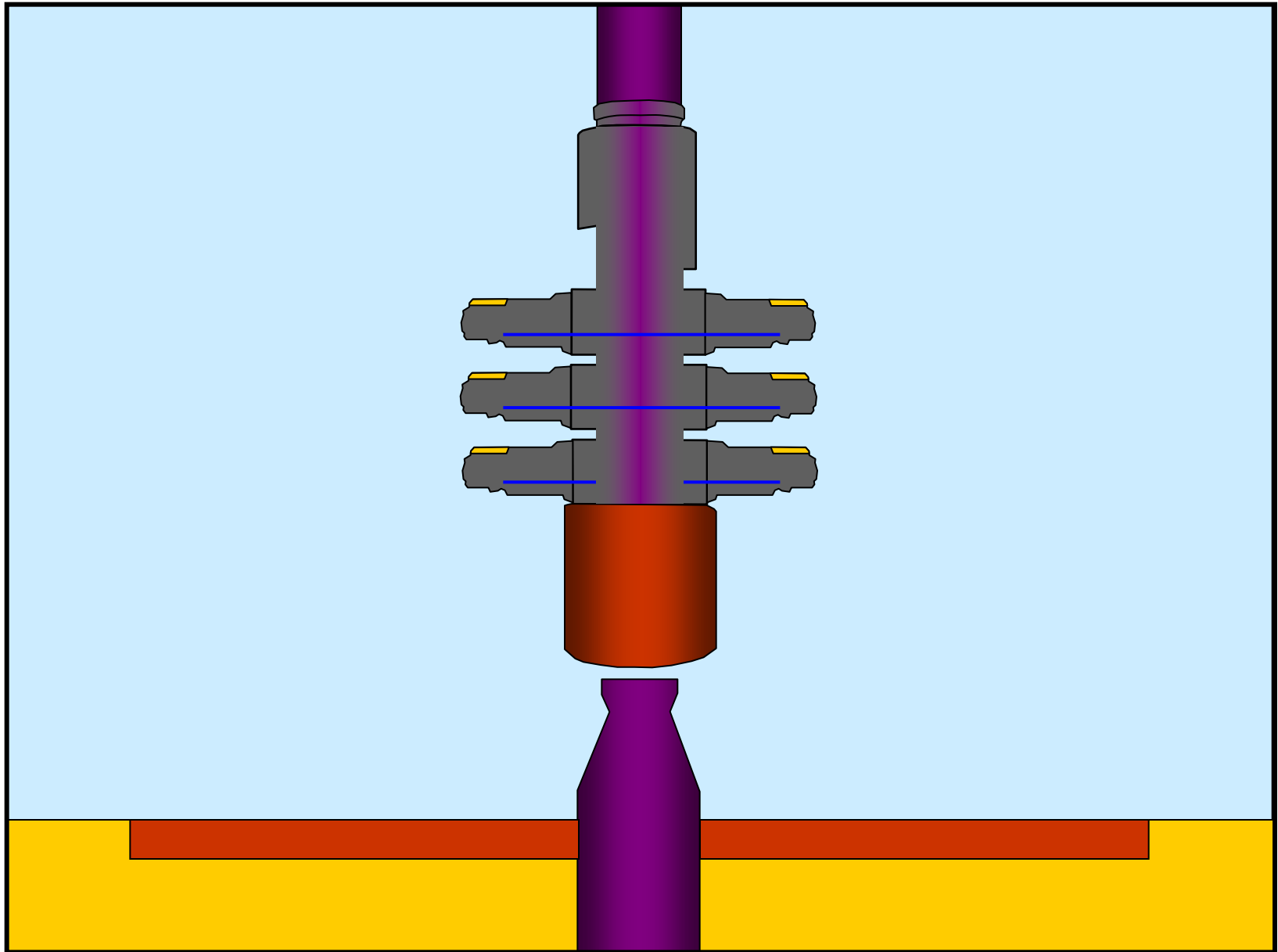
## How and when is a Blowout Preventer installed?

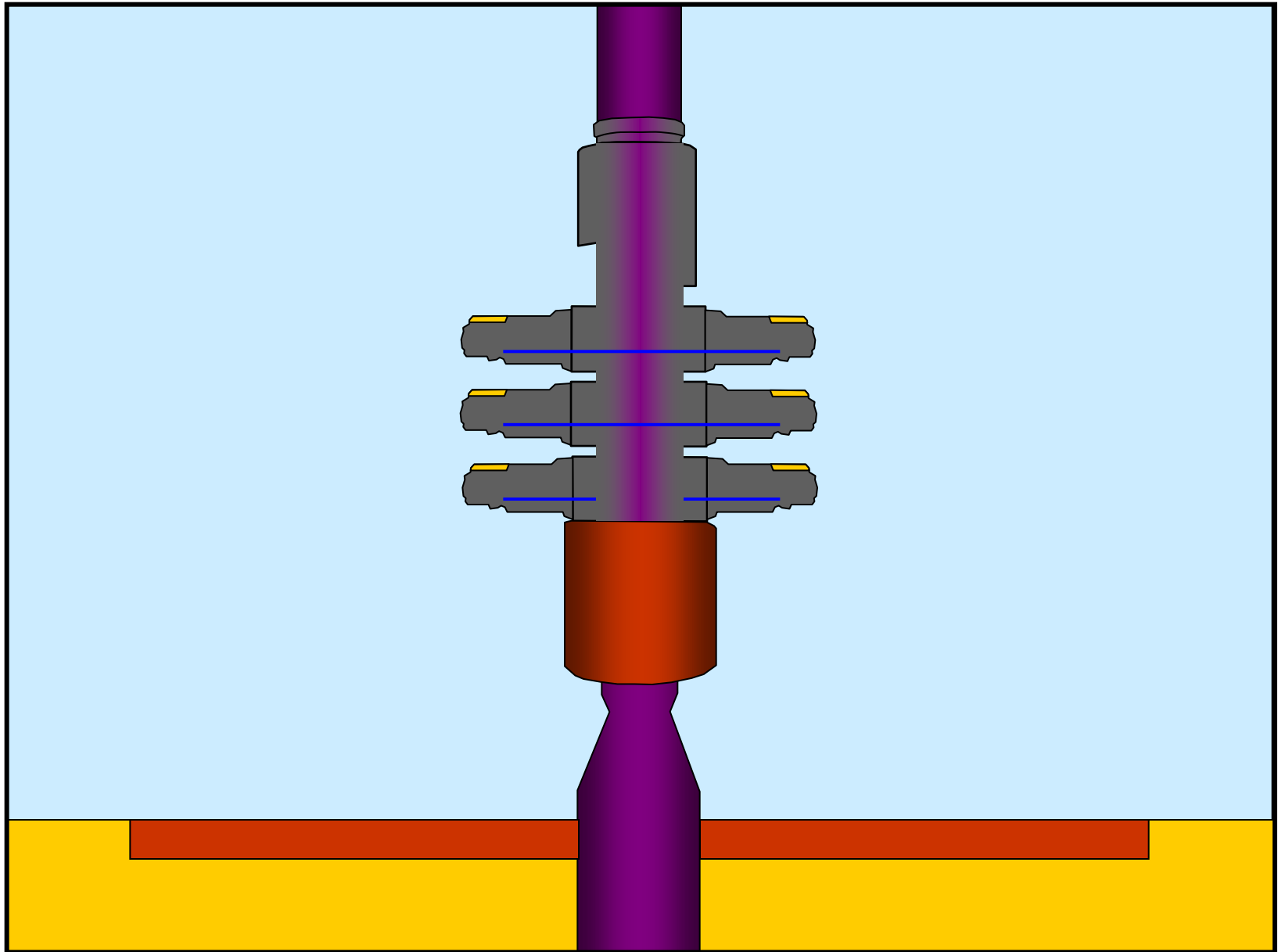
- The BOP attaches to the wellhead
- Onshore – located below the rig floor in the cellar
- Offshore (bottom supported drilling unit) – below the rig floor on the Texas deck
- Offshore (floating drilling unit) – on the seabed
- It is attached to the wellhead using flanged or collet connectors

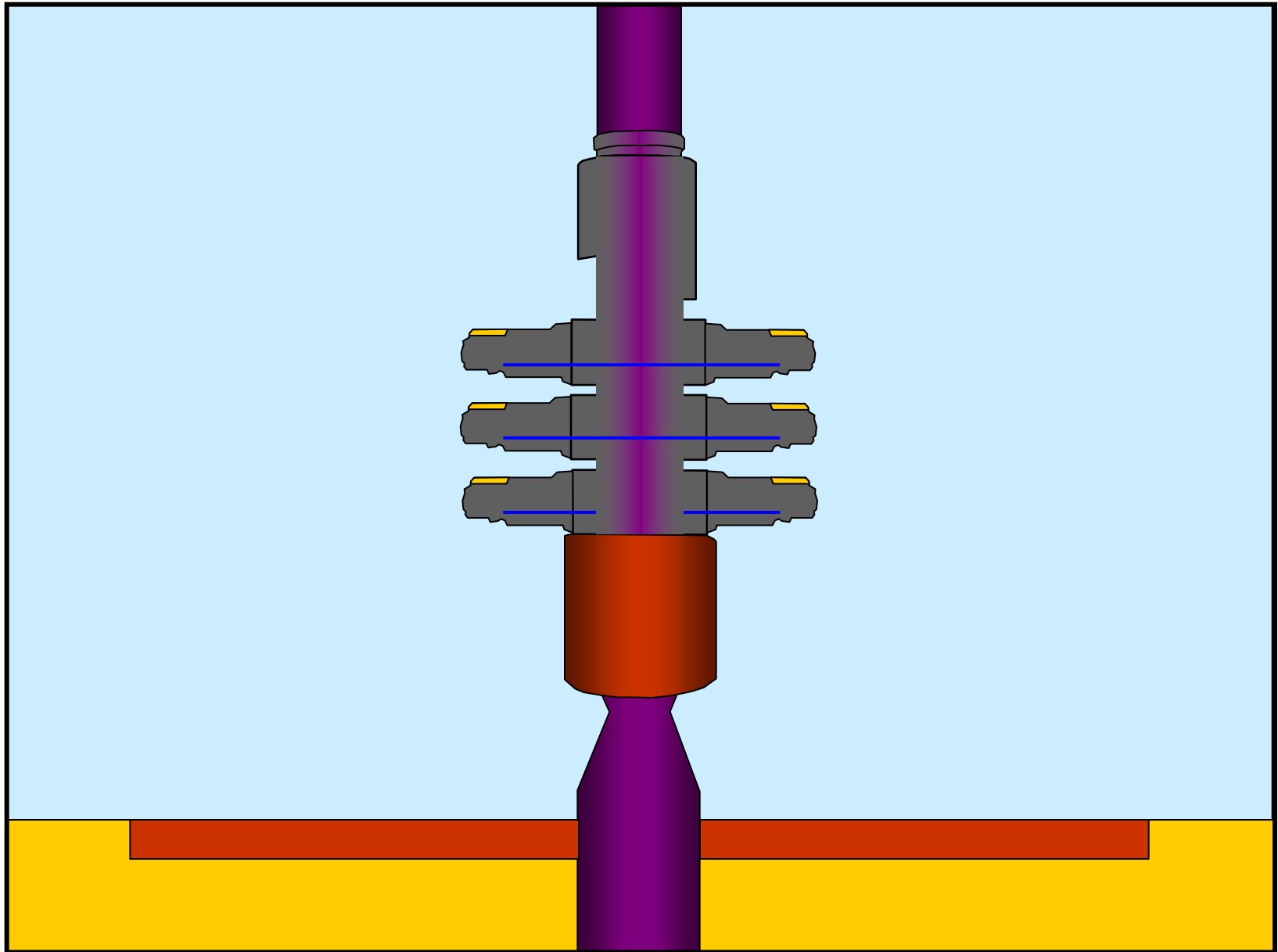


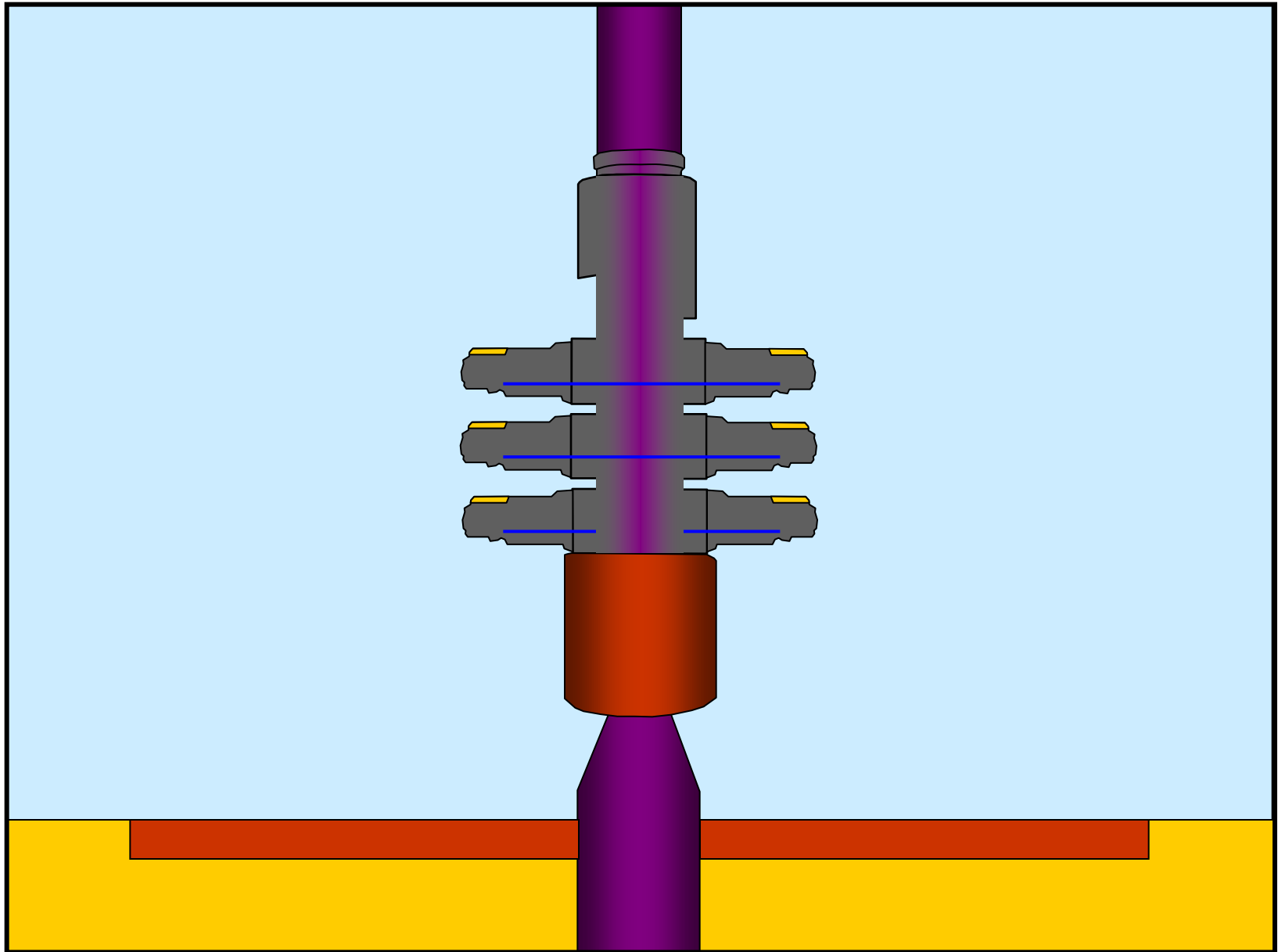


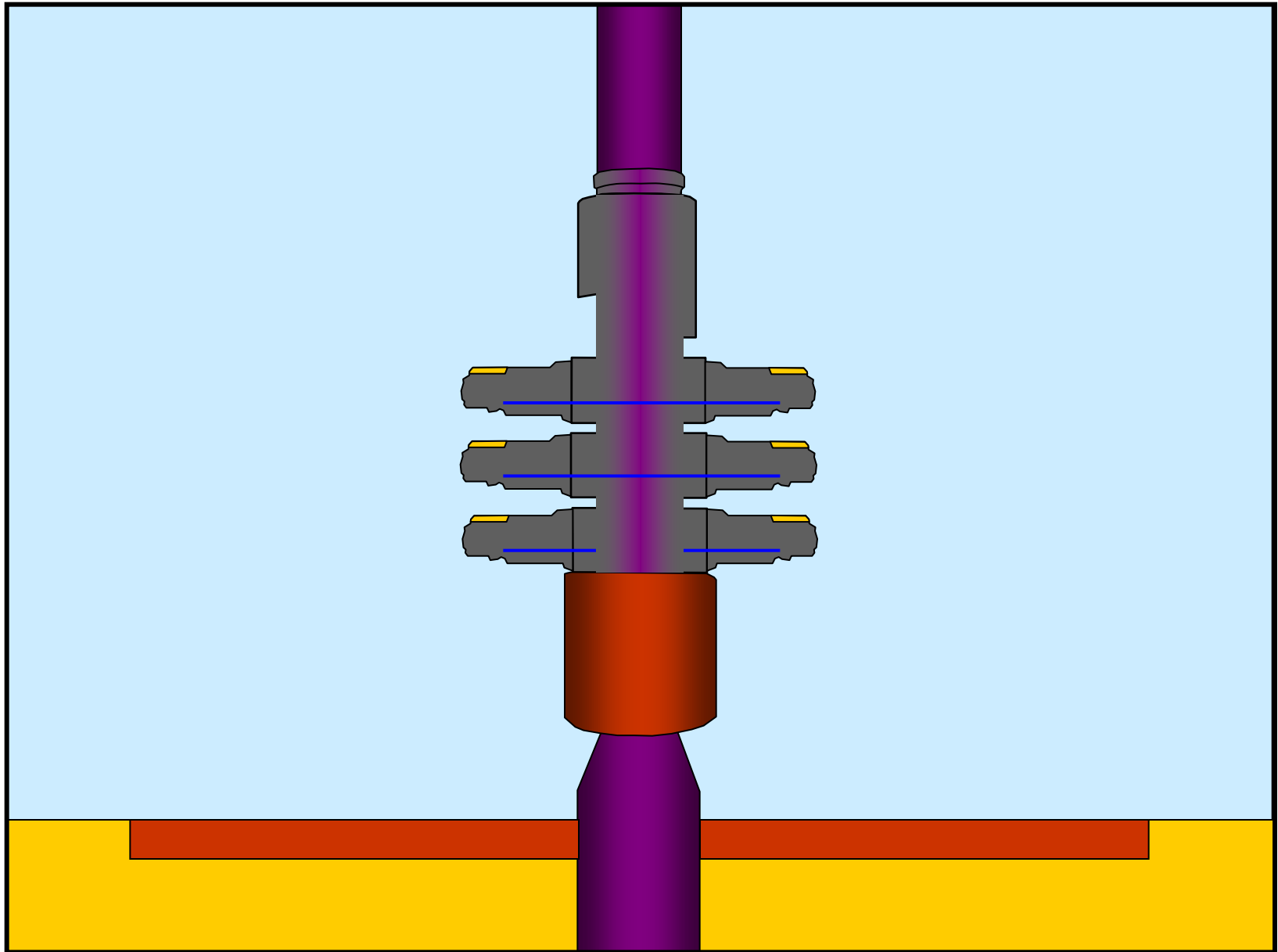


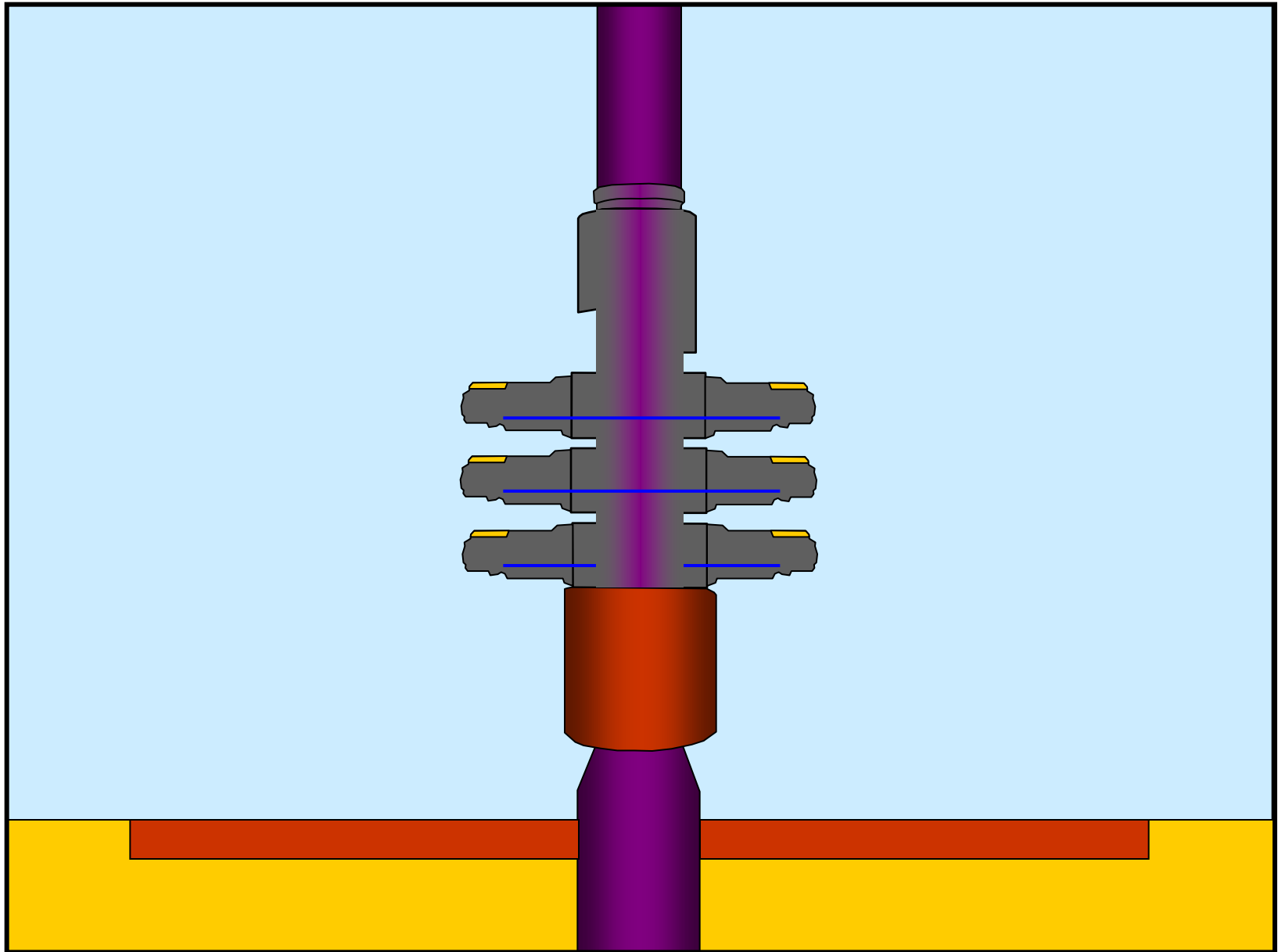


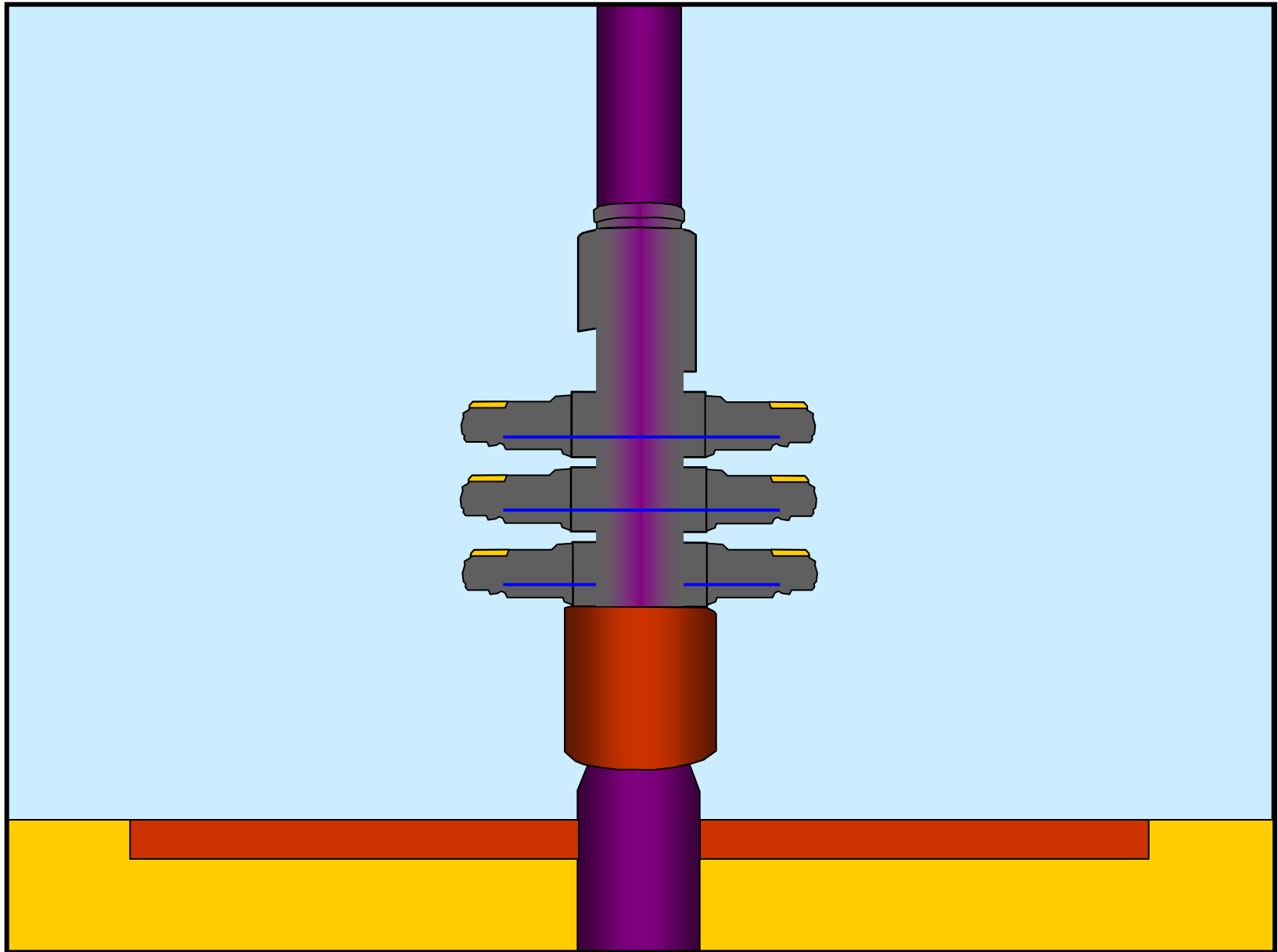


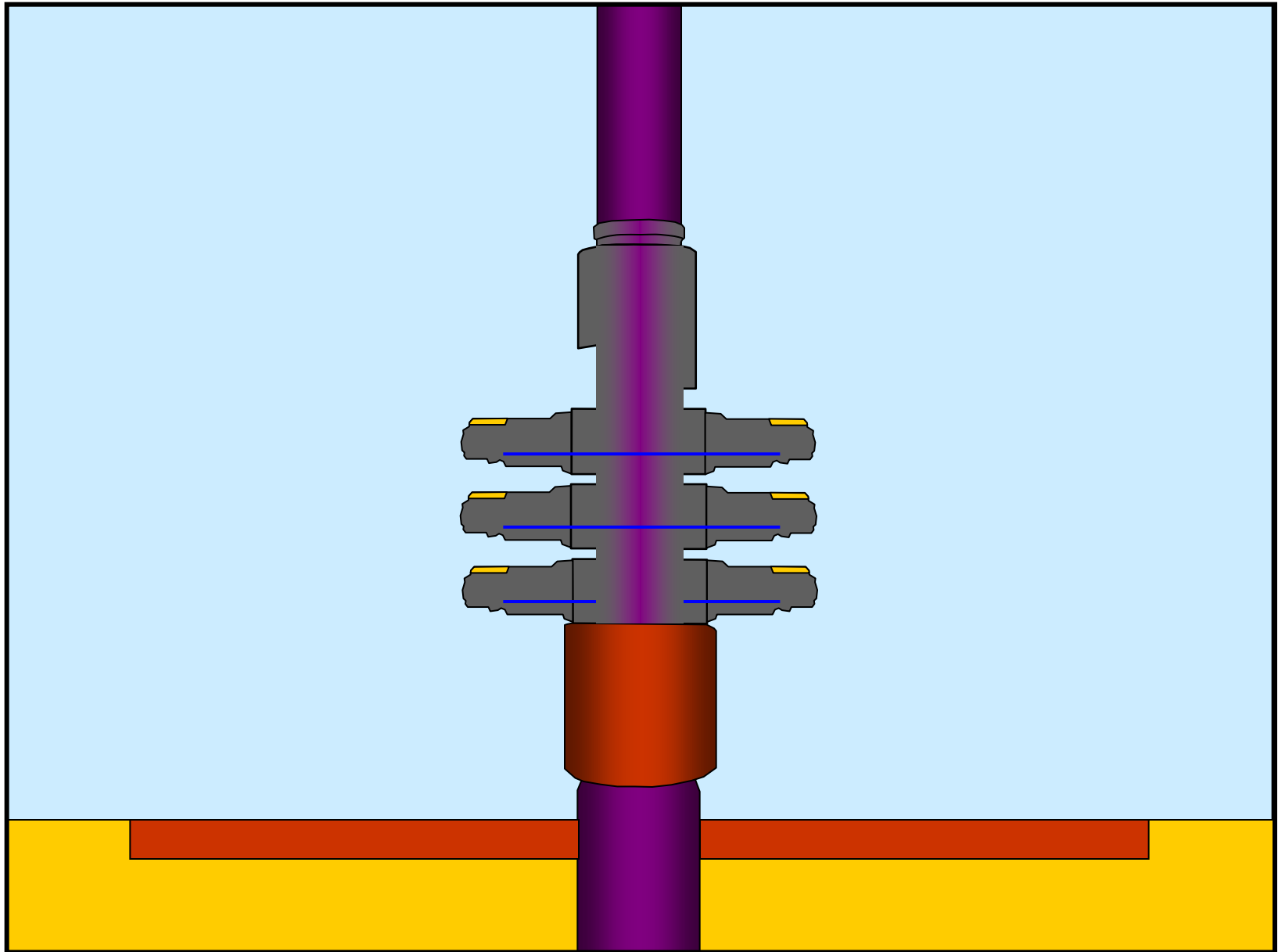


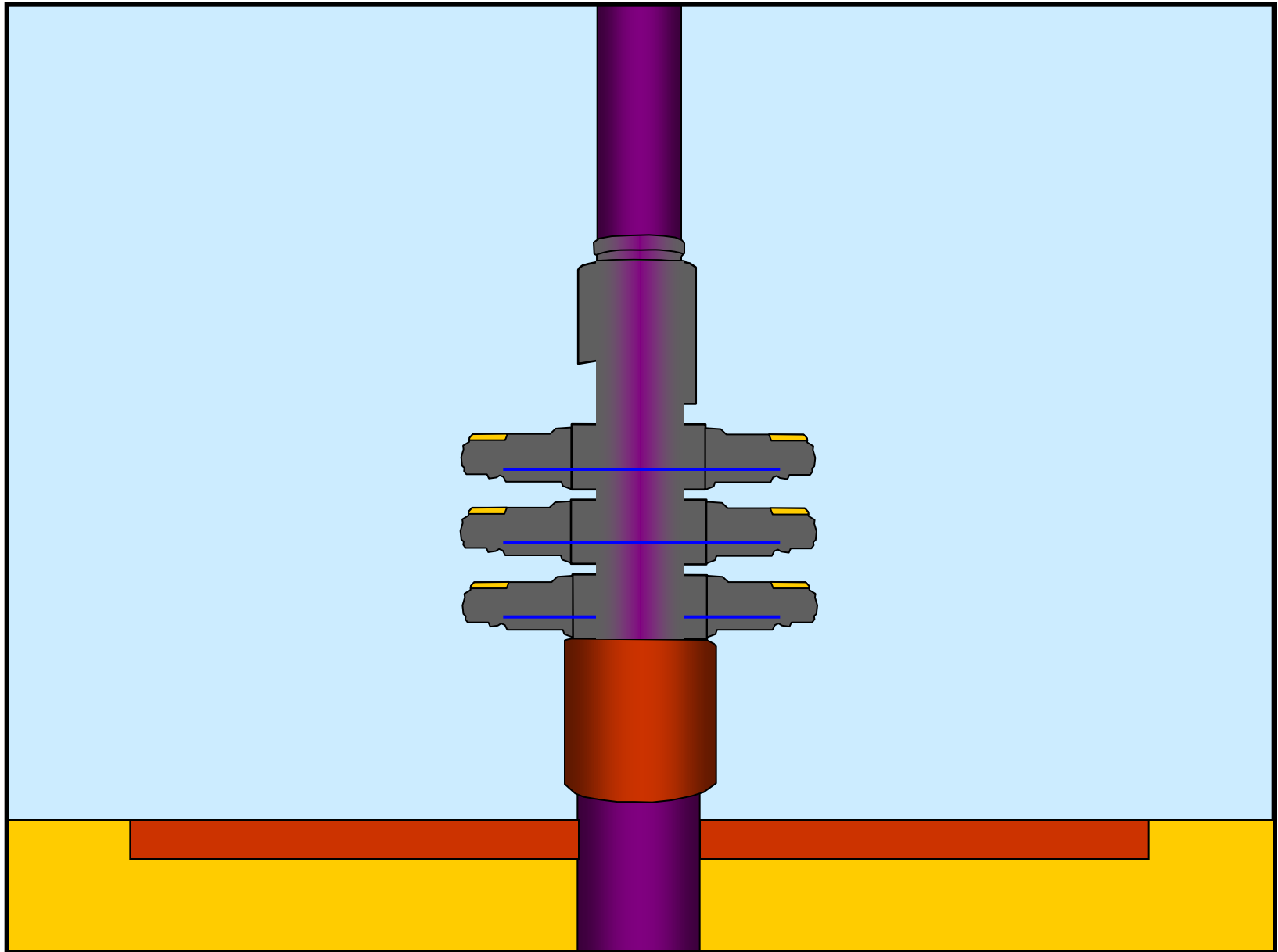


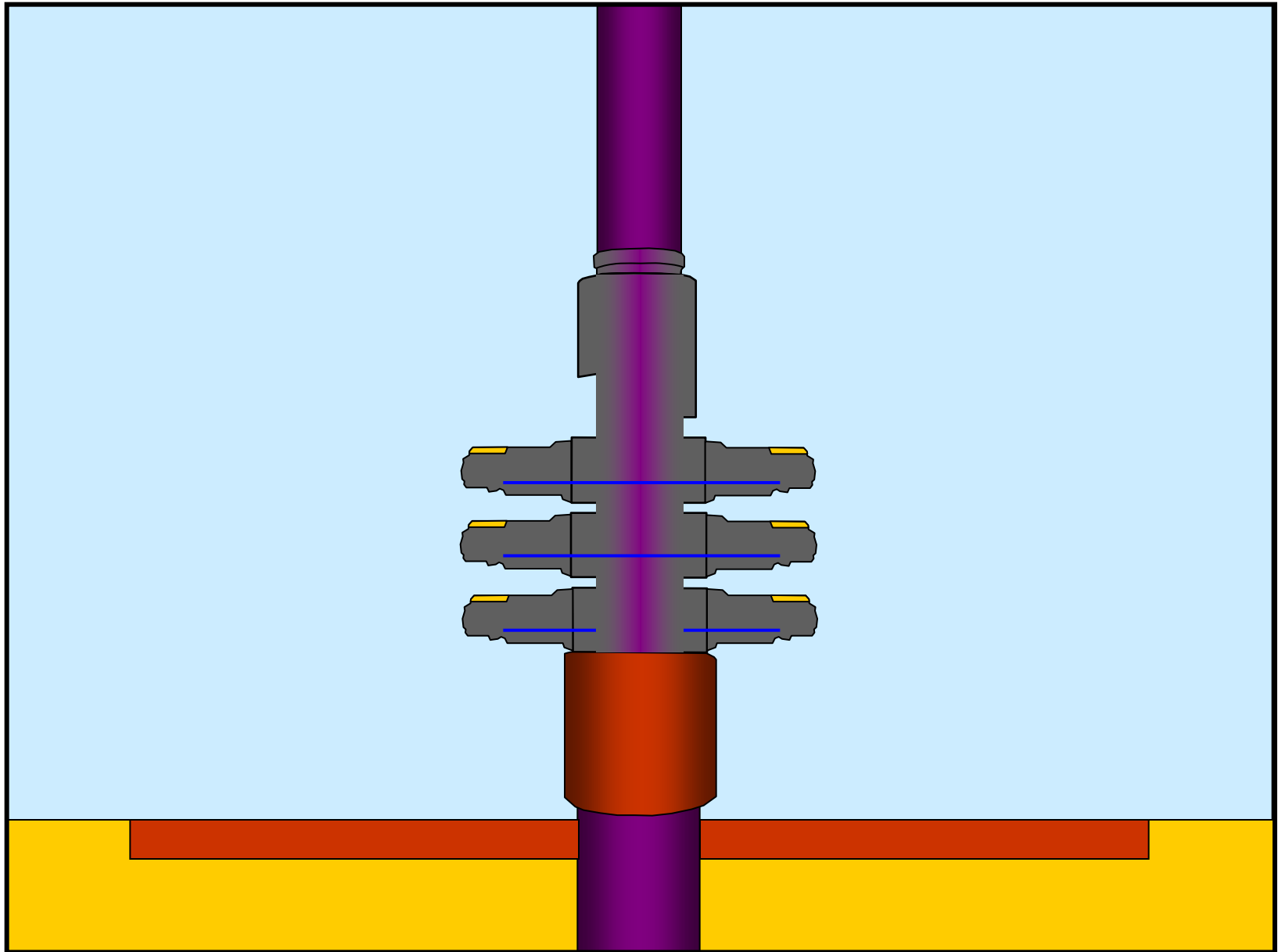


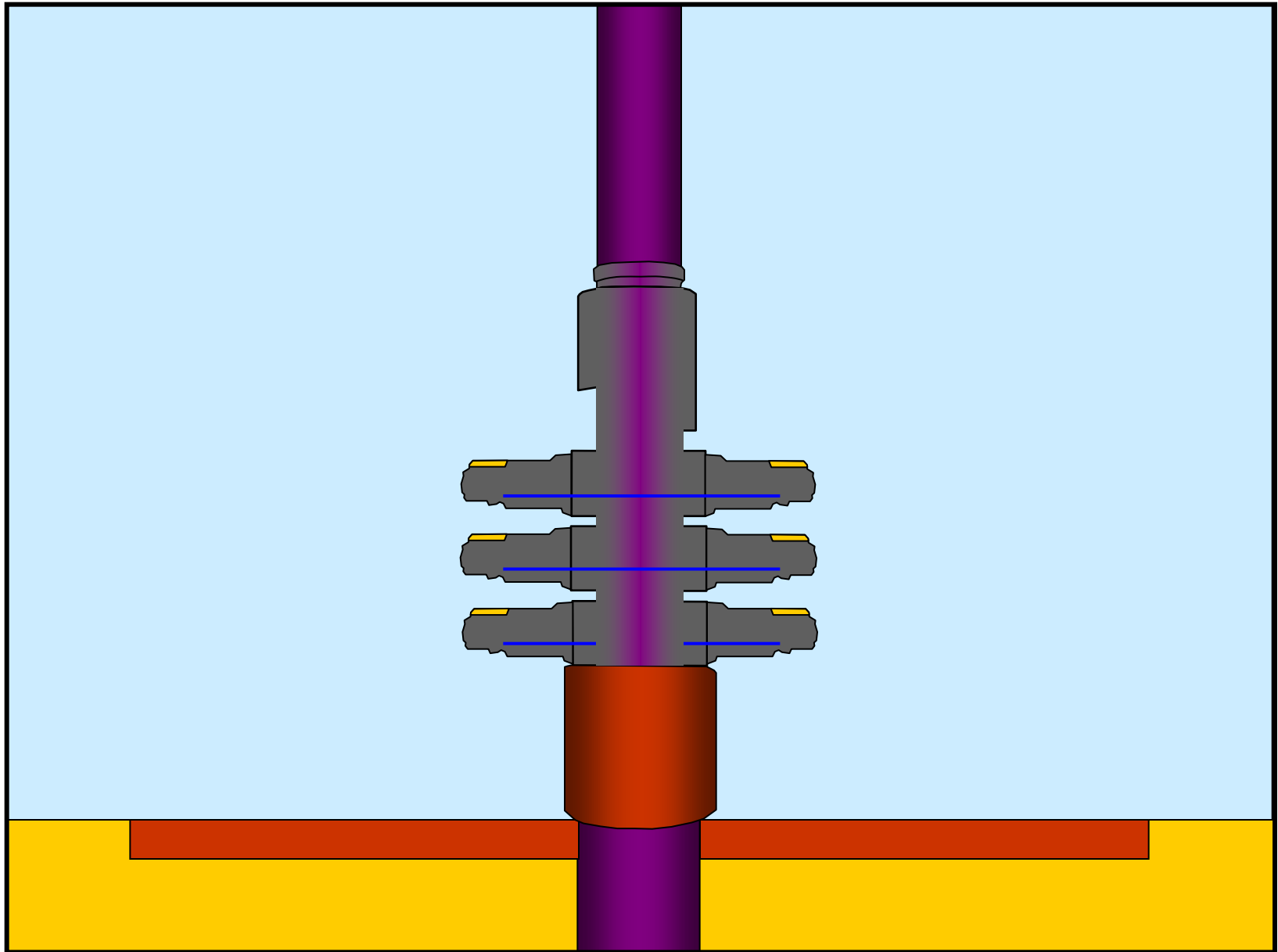


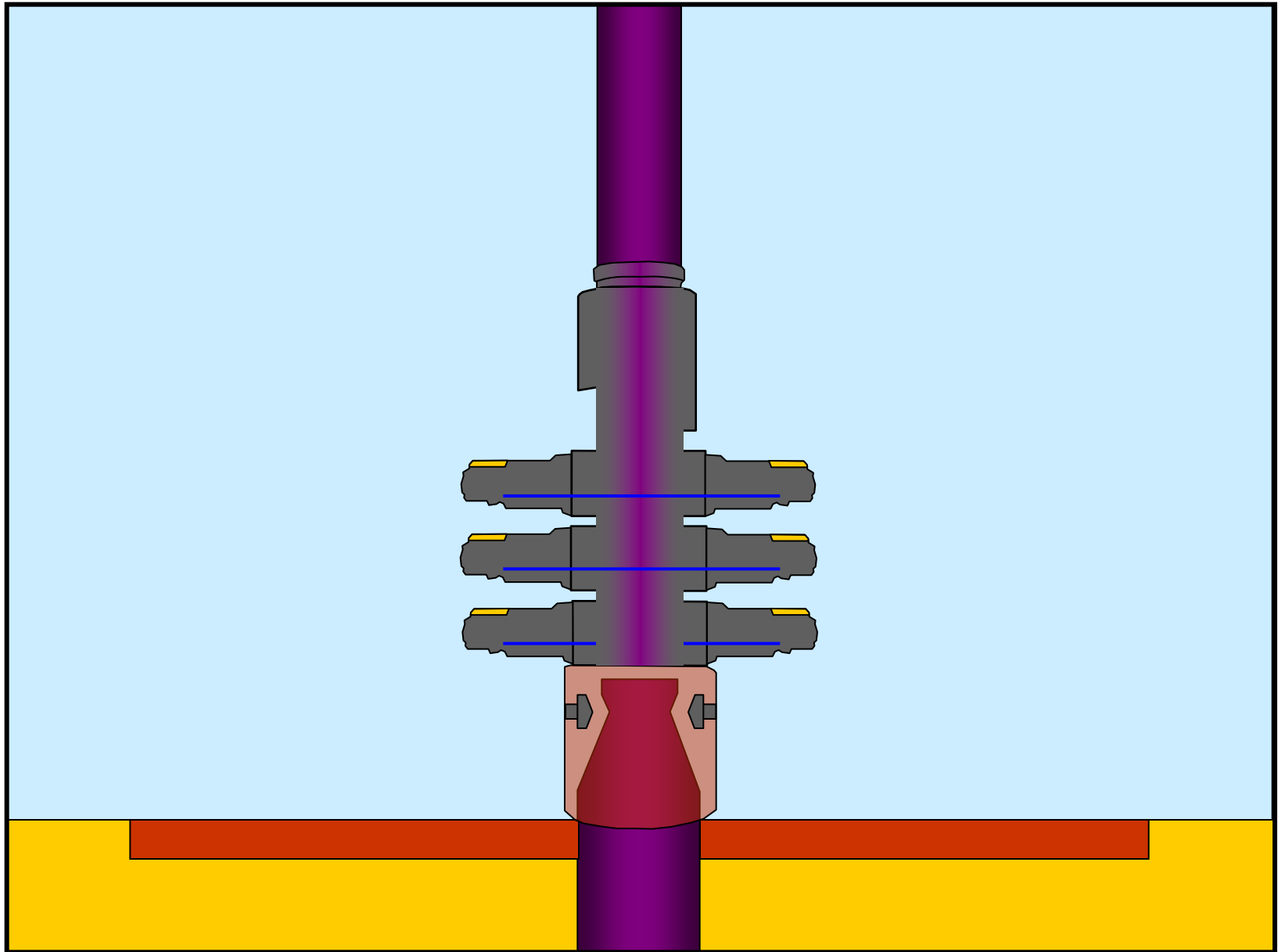


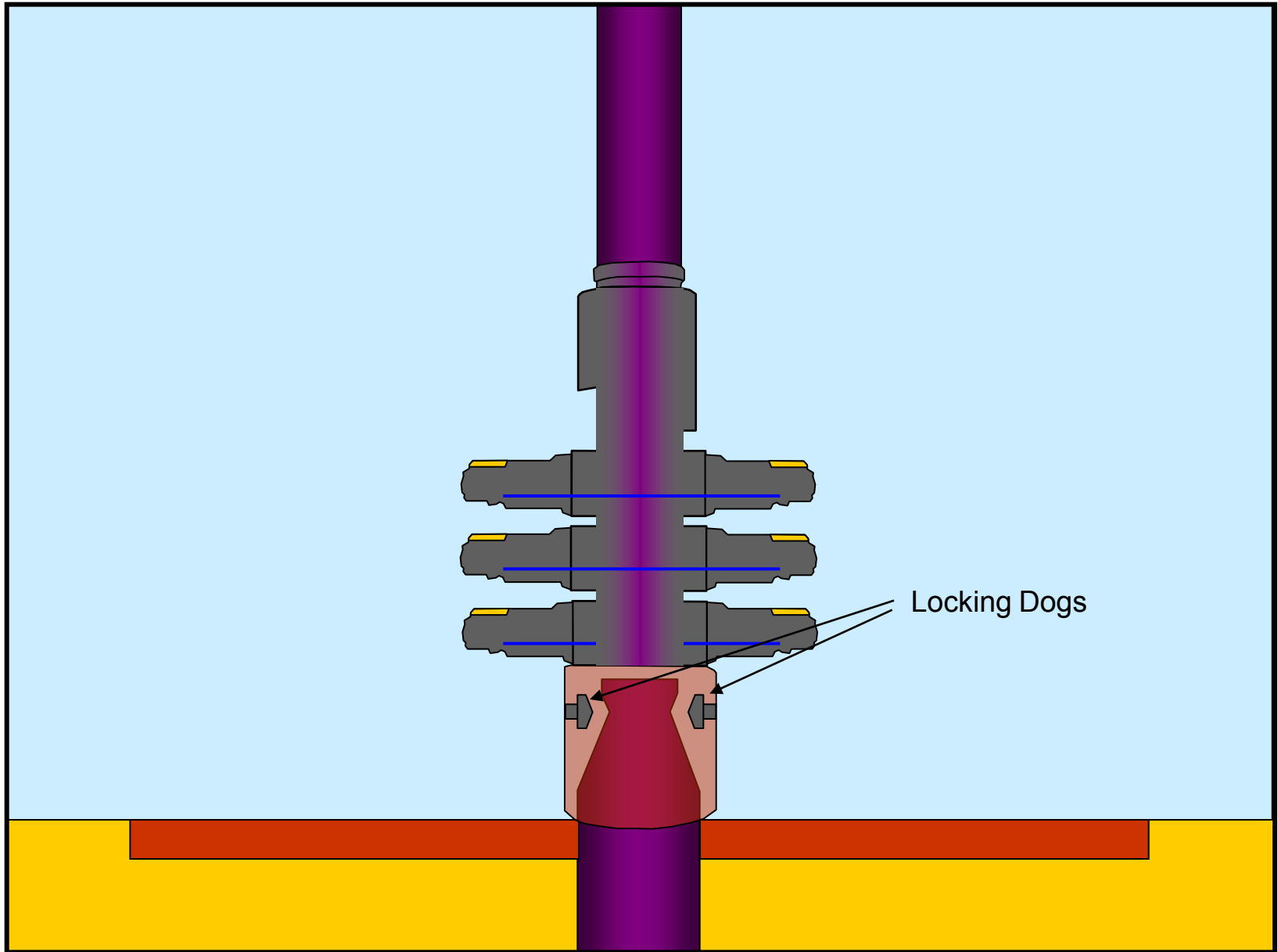


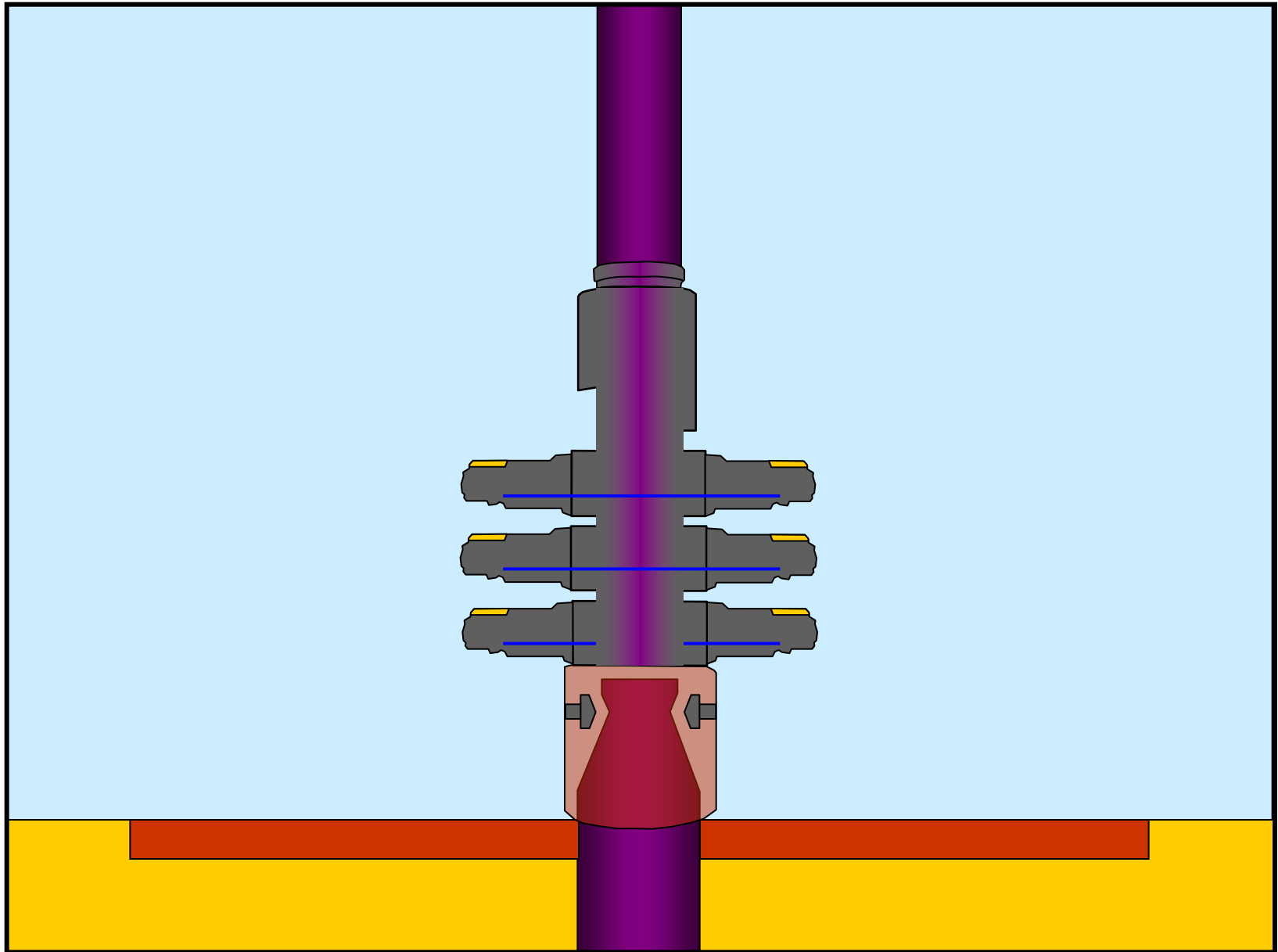


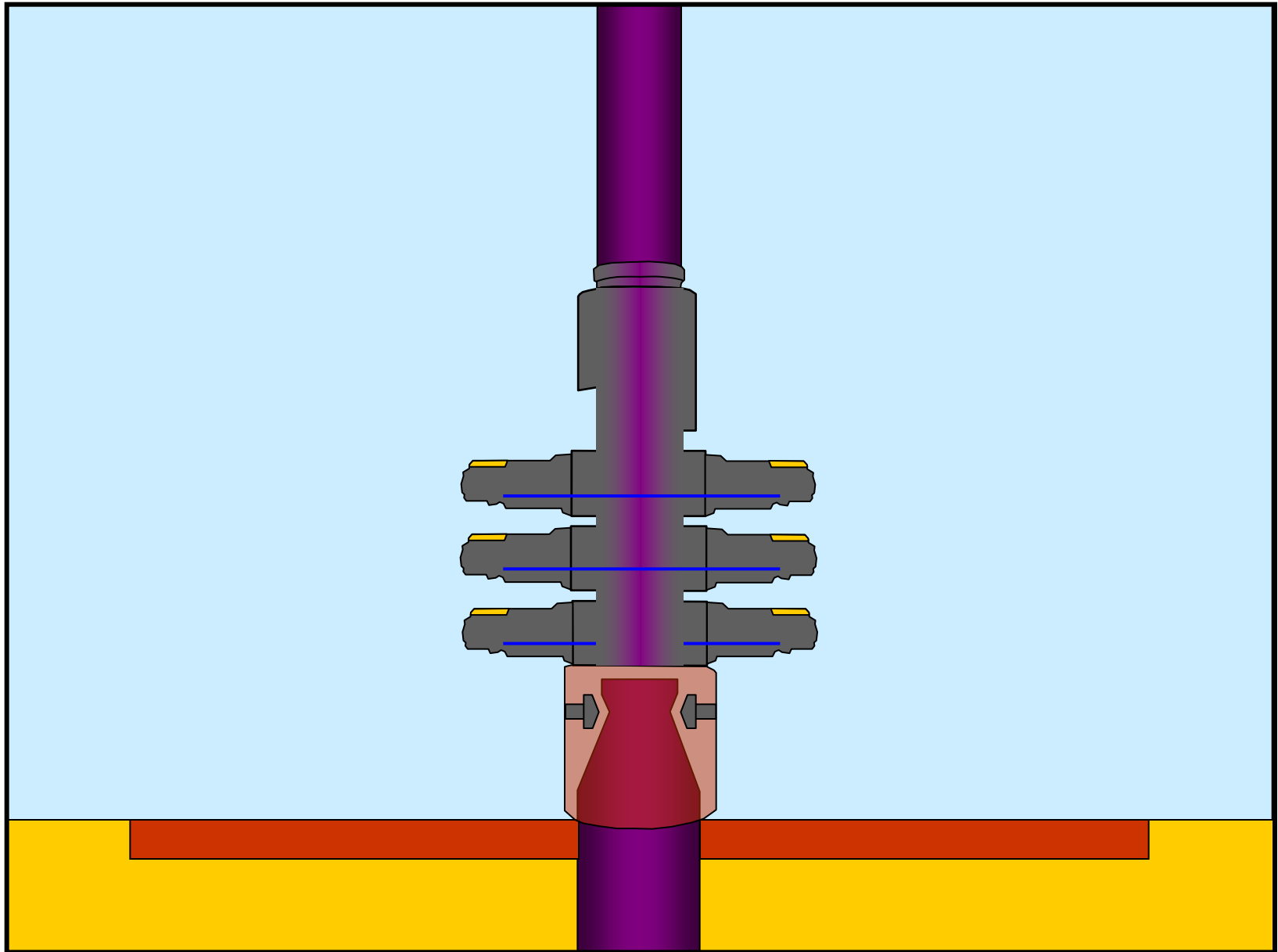


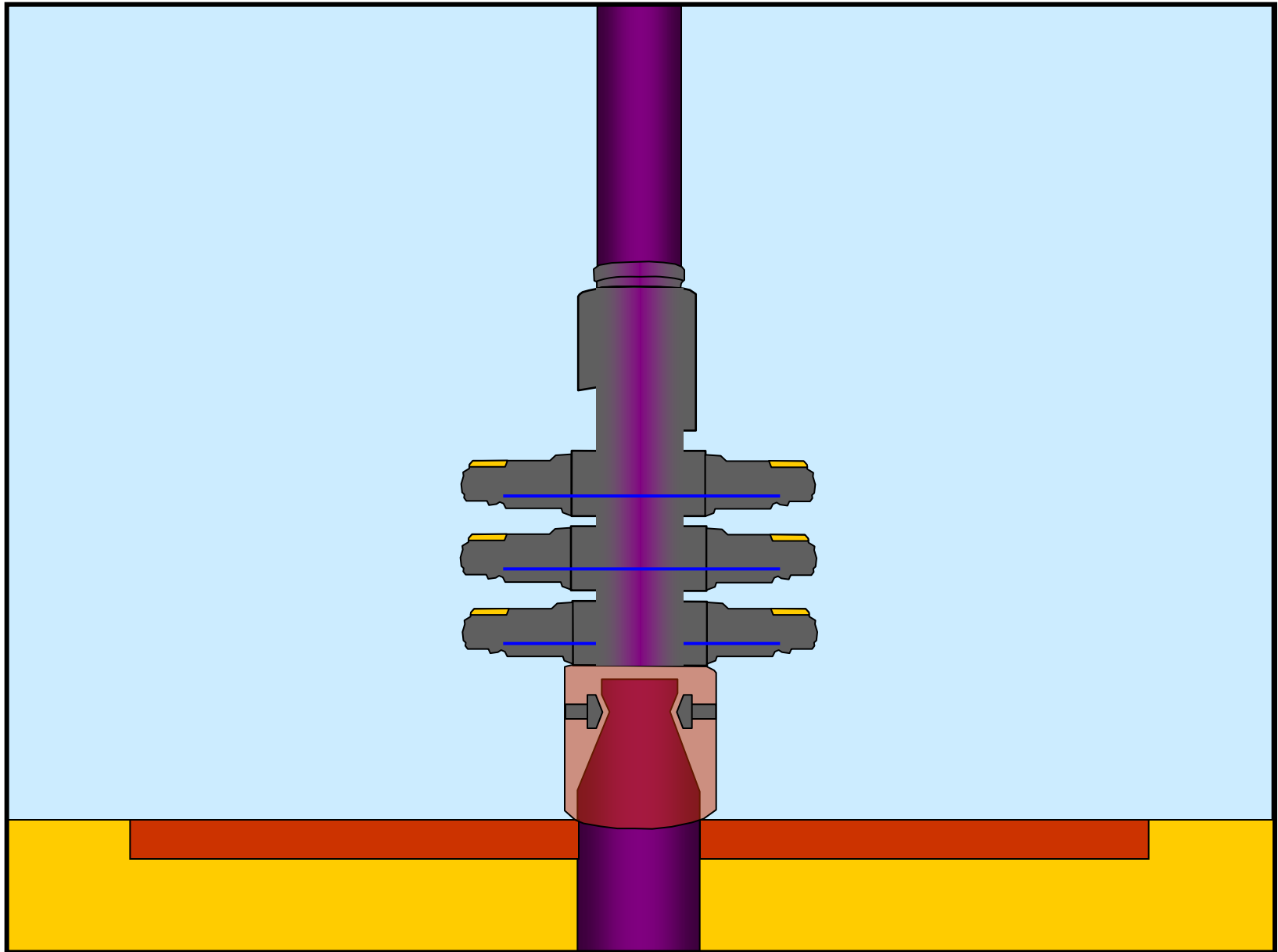


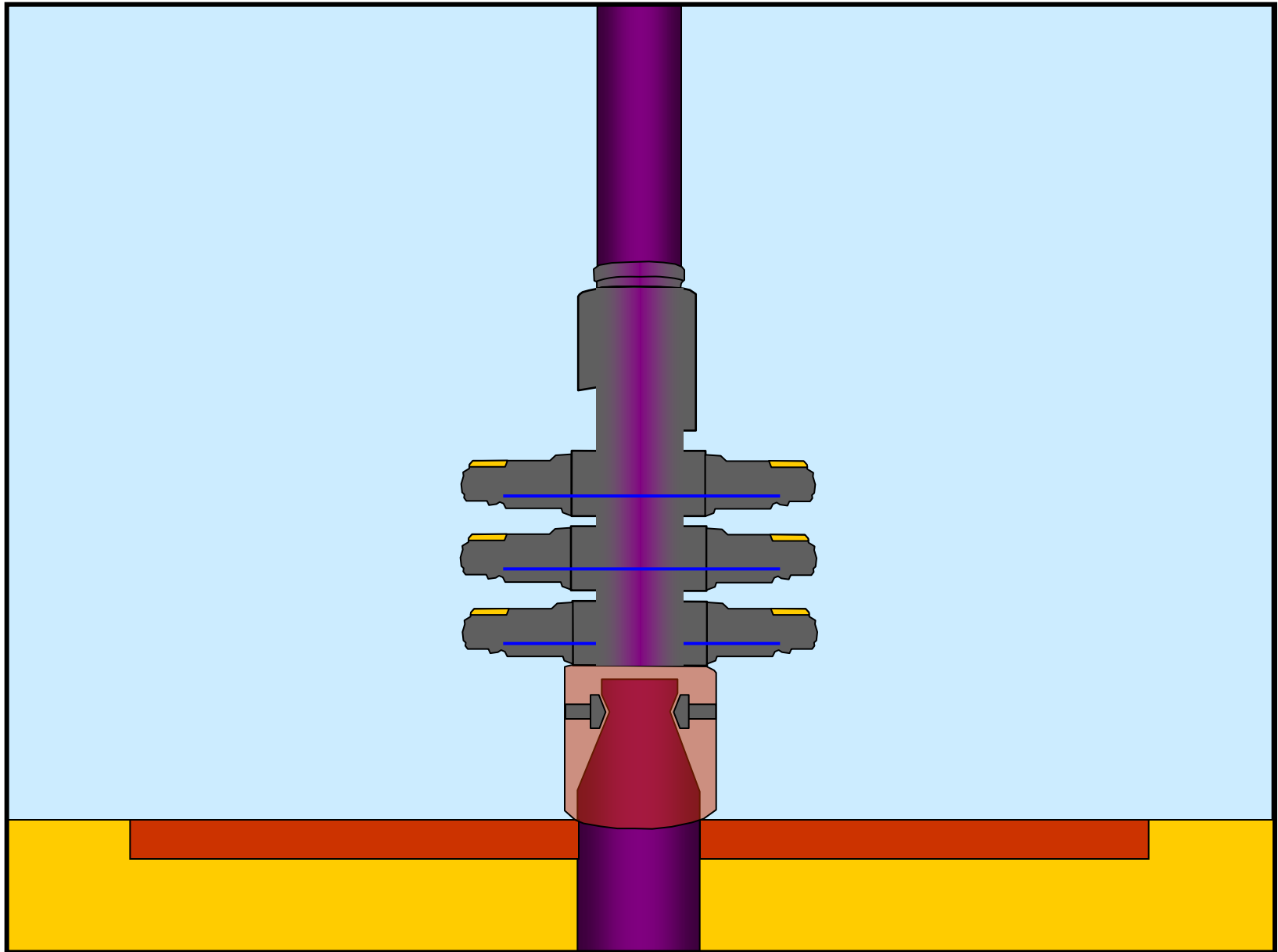


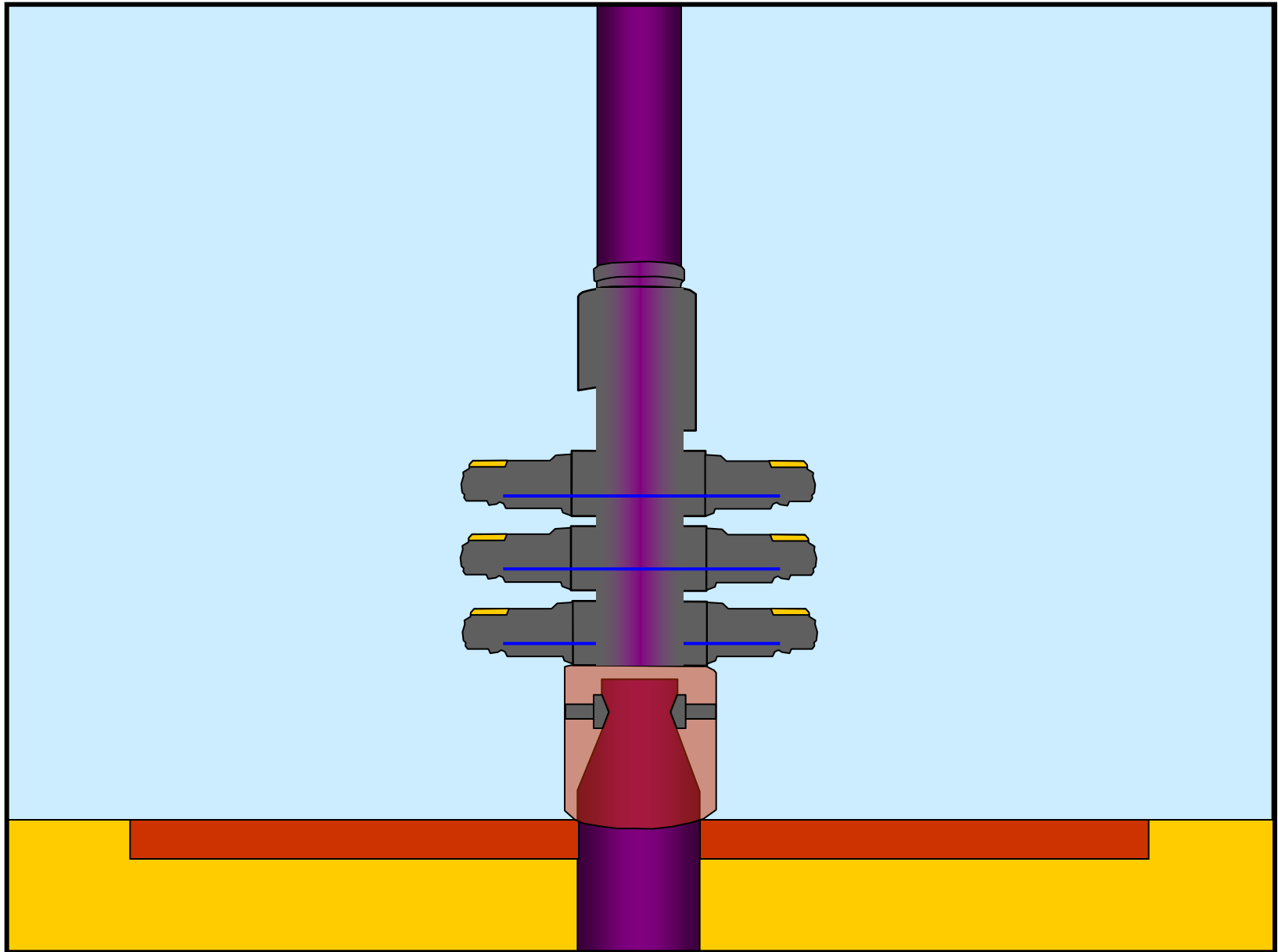


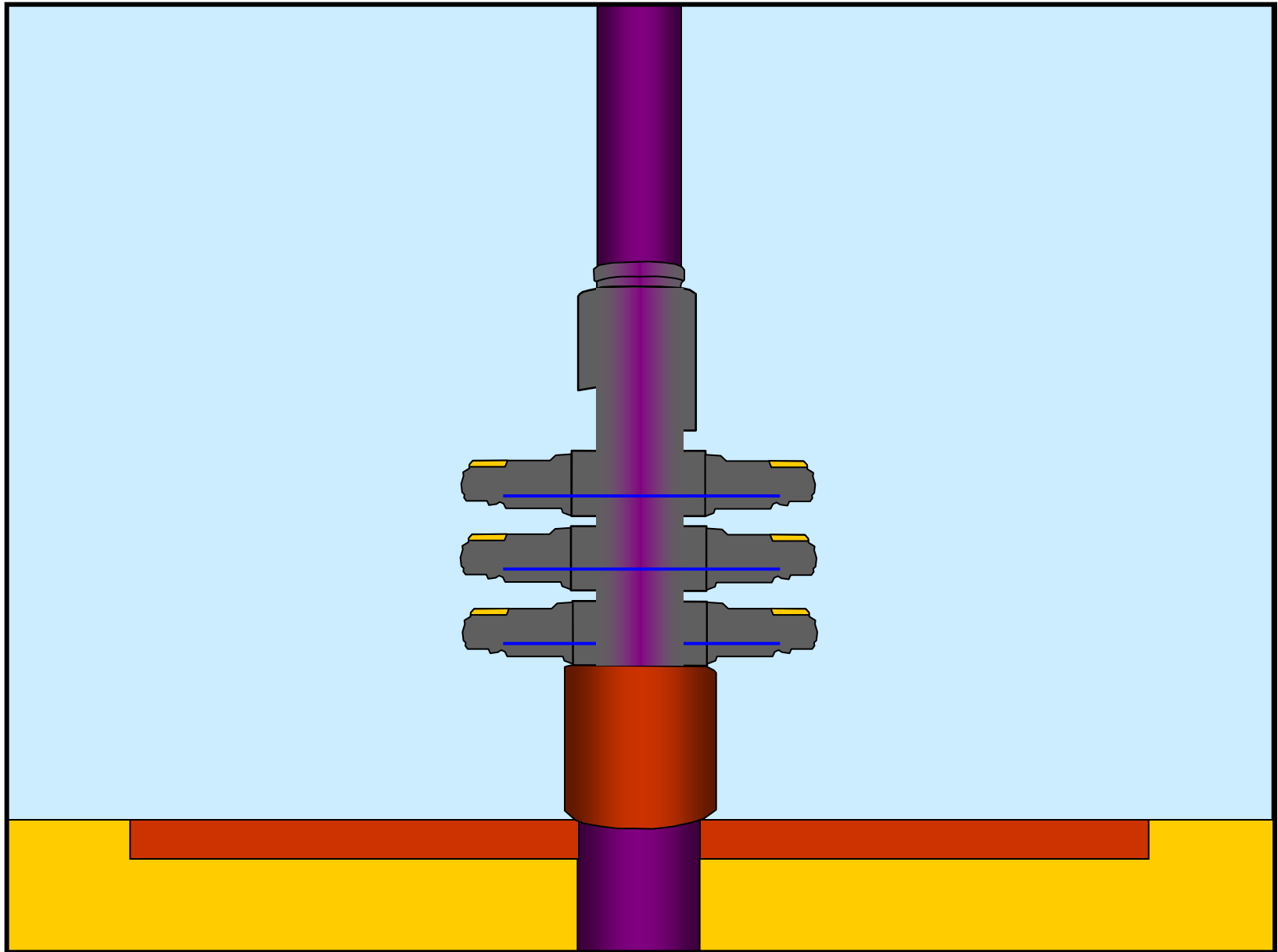










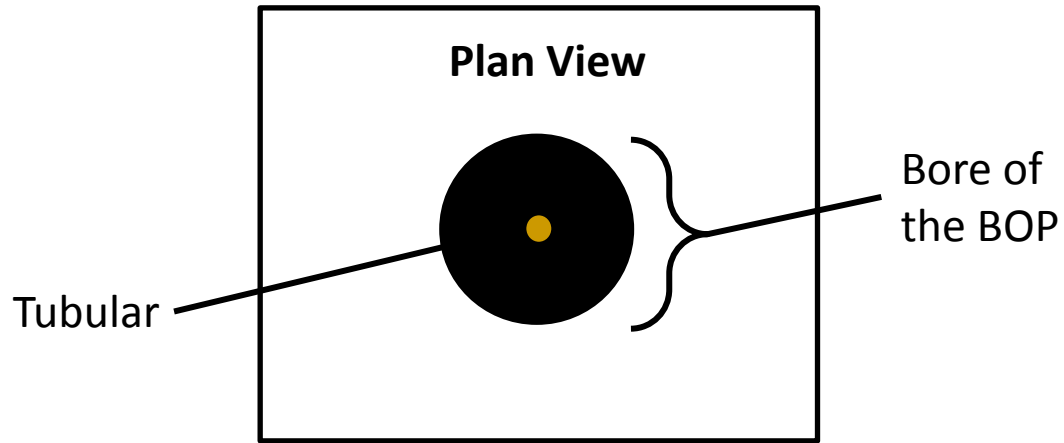


## How and when is a Blowout Preventer installed?

- The BOP attaches to the wellhead
- Onshore – located below the rig floor in the cellar
- Offshore (bottom supported drilling unit) – below the rig floor on the Texas deck
- Offshore (floating drilling unit) – on the seabed
- It is attached to the wellhead using flanged or collet connectors
- Normally installed after setting the surface casing string

## Basic design and operating principles

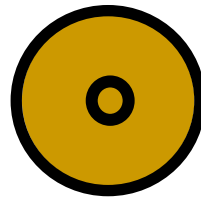
- Main design considerations
  - To make an annular seal for equipment of different shapes and sizes



## Basic design and operating principles

- Main design considerations
  - making an annular seal for equipment of different shapes and sizes
  - to cut through equipment in the bore of the BOP

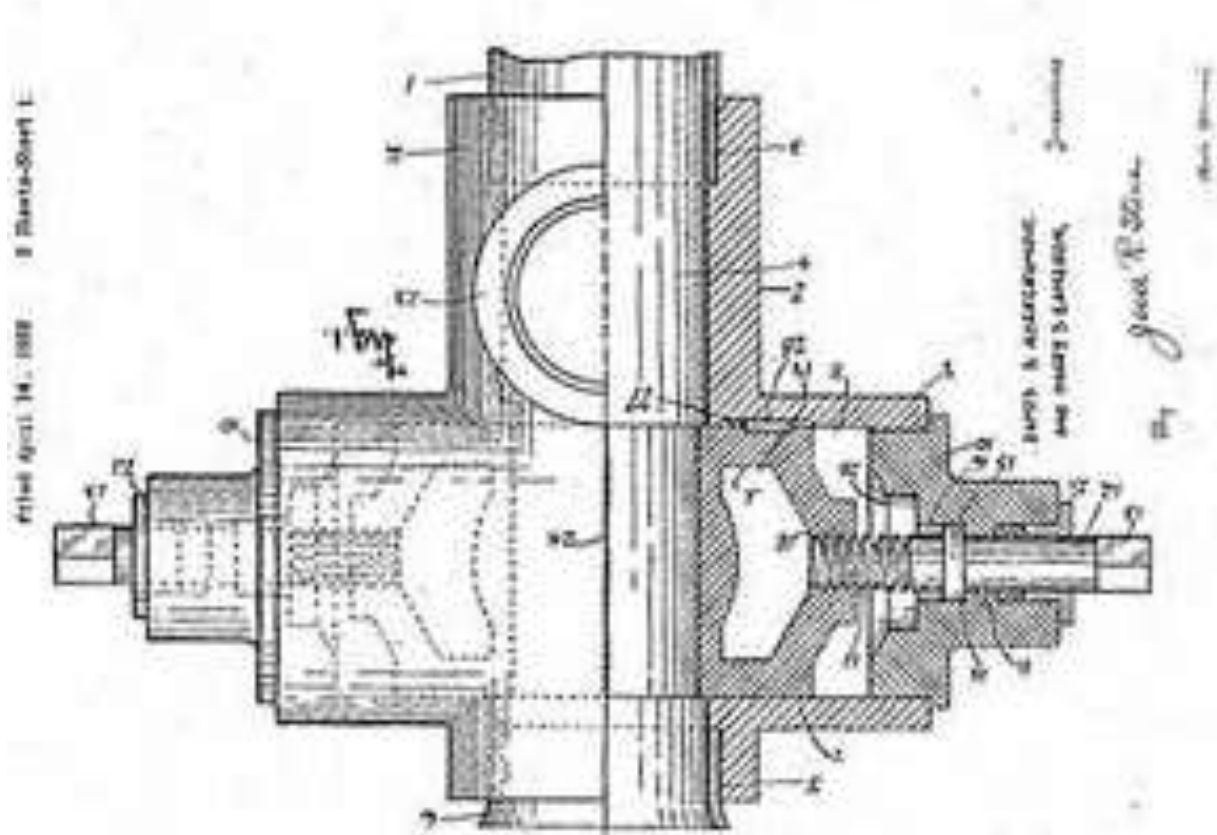
**Plan View**



## Basic design and operating principle

- Main design considerations
  - making an annular seal for equipment of different shapes and sizes
  - the ability to cut through equipment in the bore of the BOP
- How is the power delivered?
  - Very early days – using a screwing mechanism

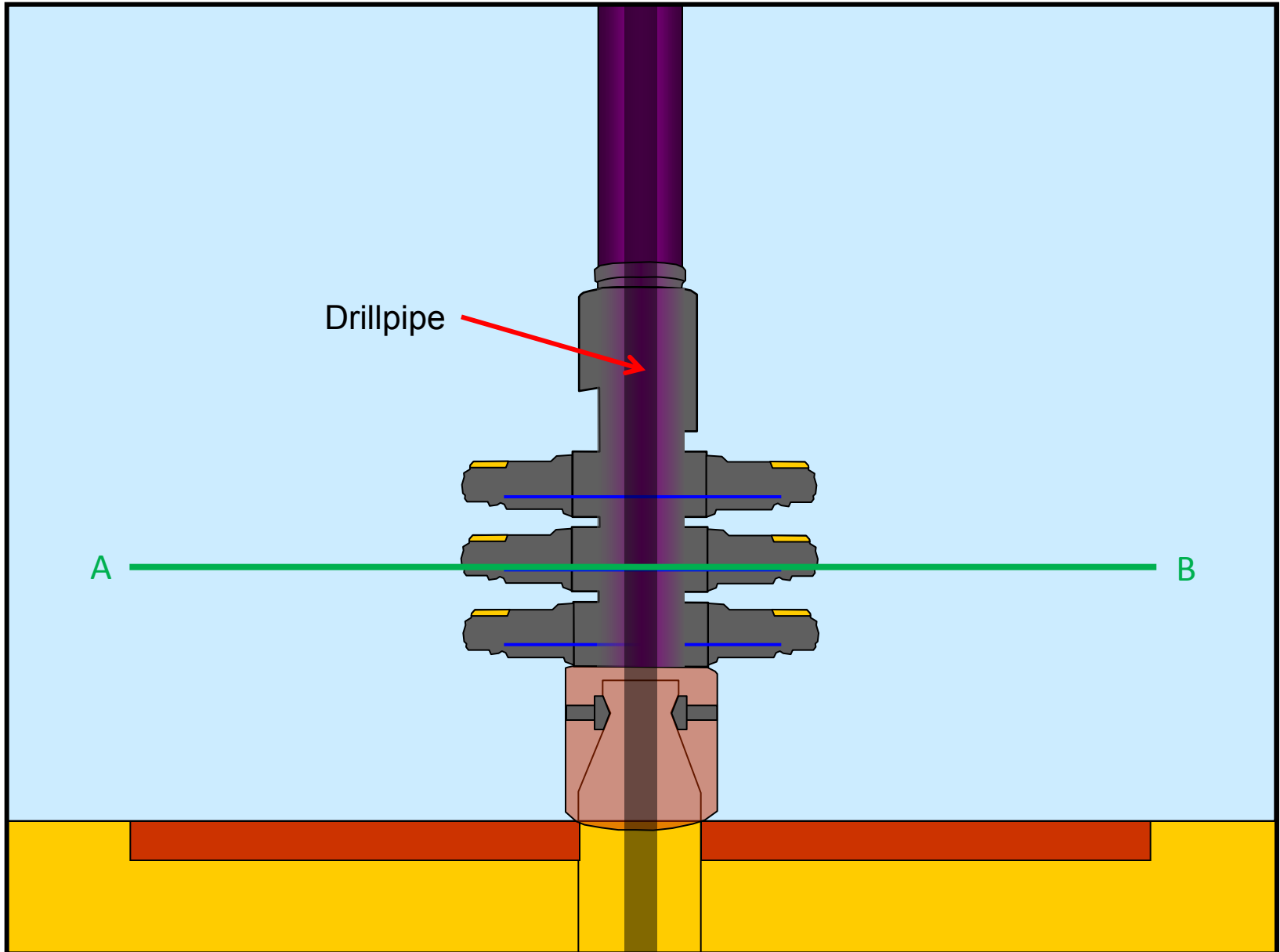
Abercrombie and Cameron patented design circa 1920



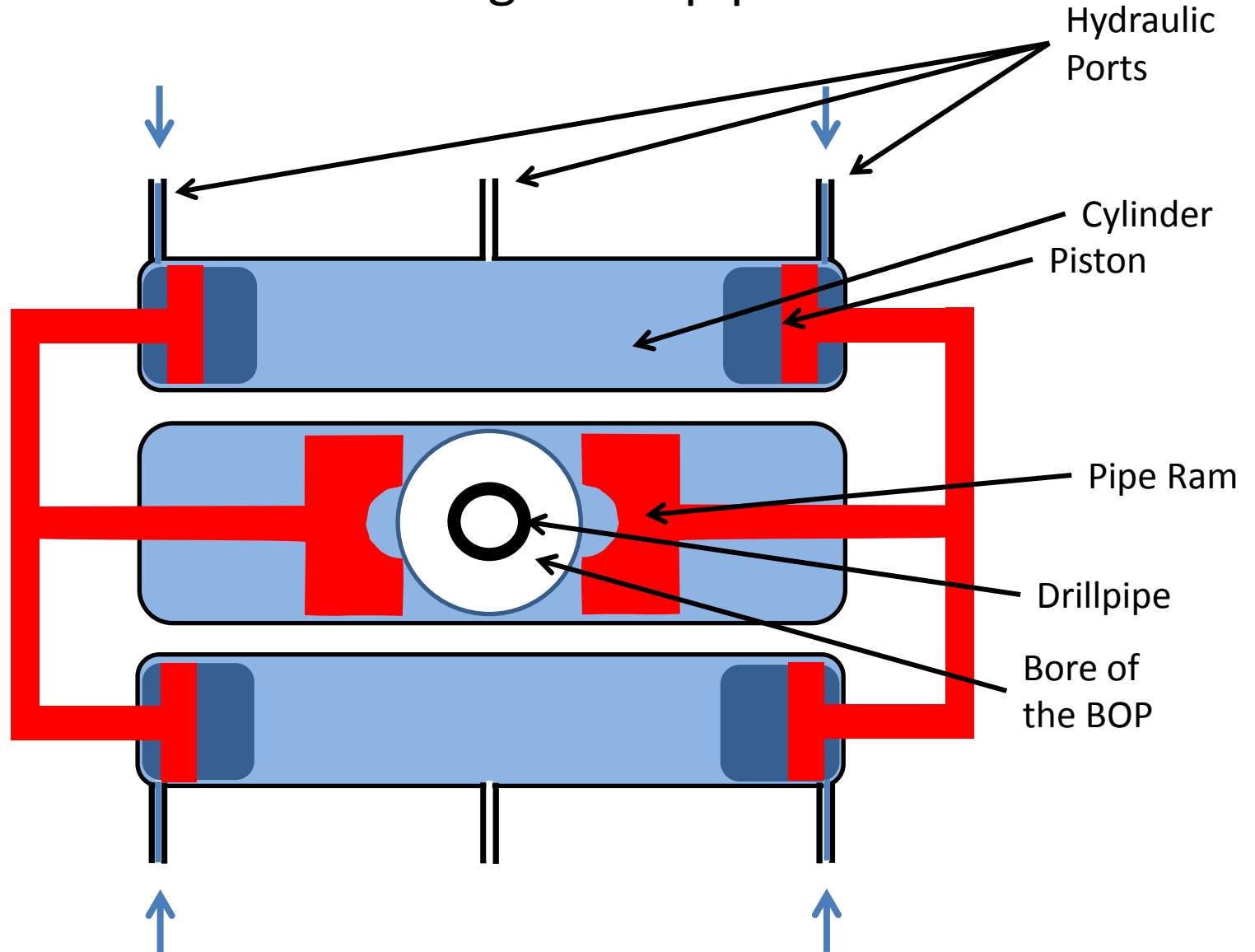


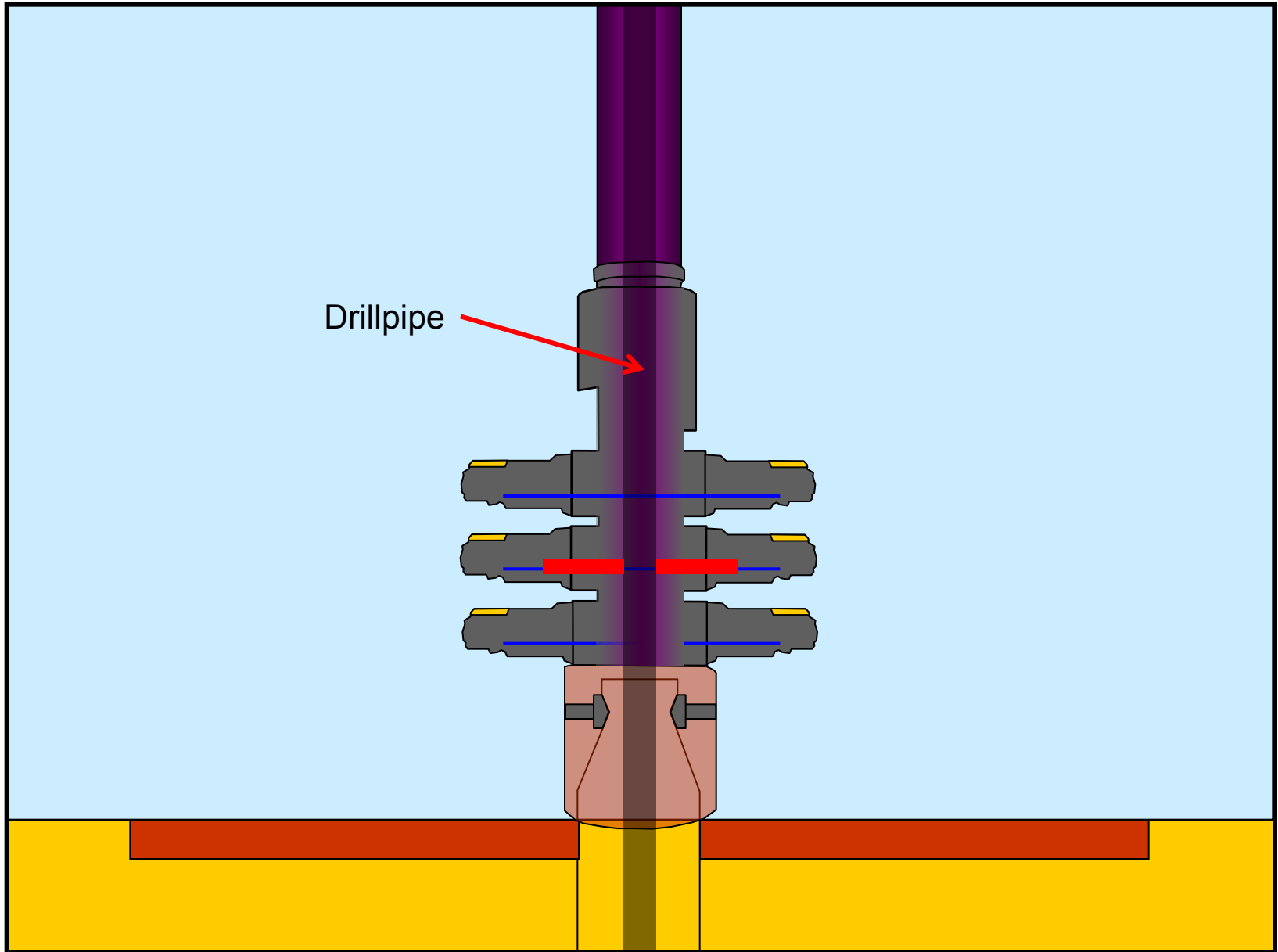
## Basic design and operating principle

- Main design considerations
  - making an annular seal for equipment of different shapes and sizes
  - the ability to cut through equipment in the bore of the BOP
- How is the power delivered?
  - Very early days – using a screwing mechanism
  - Subsequently – using hydraulic power

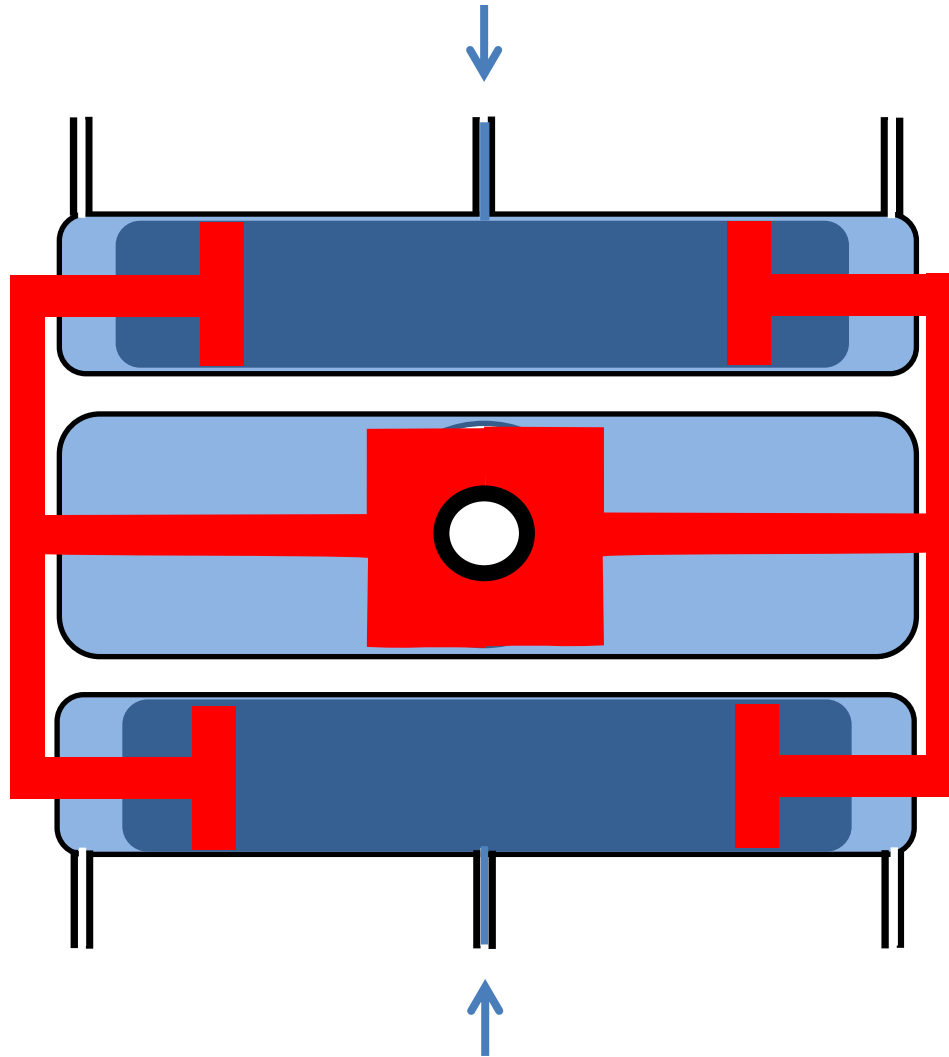


# Plan view through BOP pipe ram





Plan view through BOP pipe ram



## BOP Control Systems

- The function of the control system is to ensure that hydraulic pressure is conveyed to the right place, at the correct pressure as quickly as possible
- Onshore – fairly basic system

## Onshore Koomey Unit



## Onshore BOP Control Panel

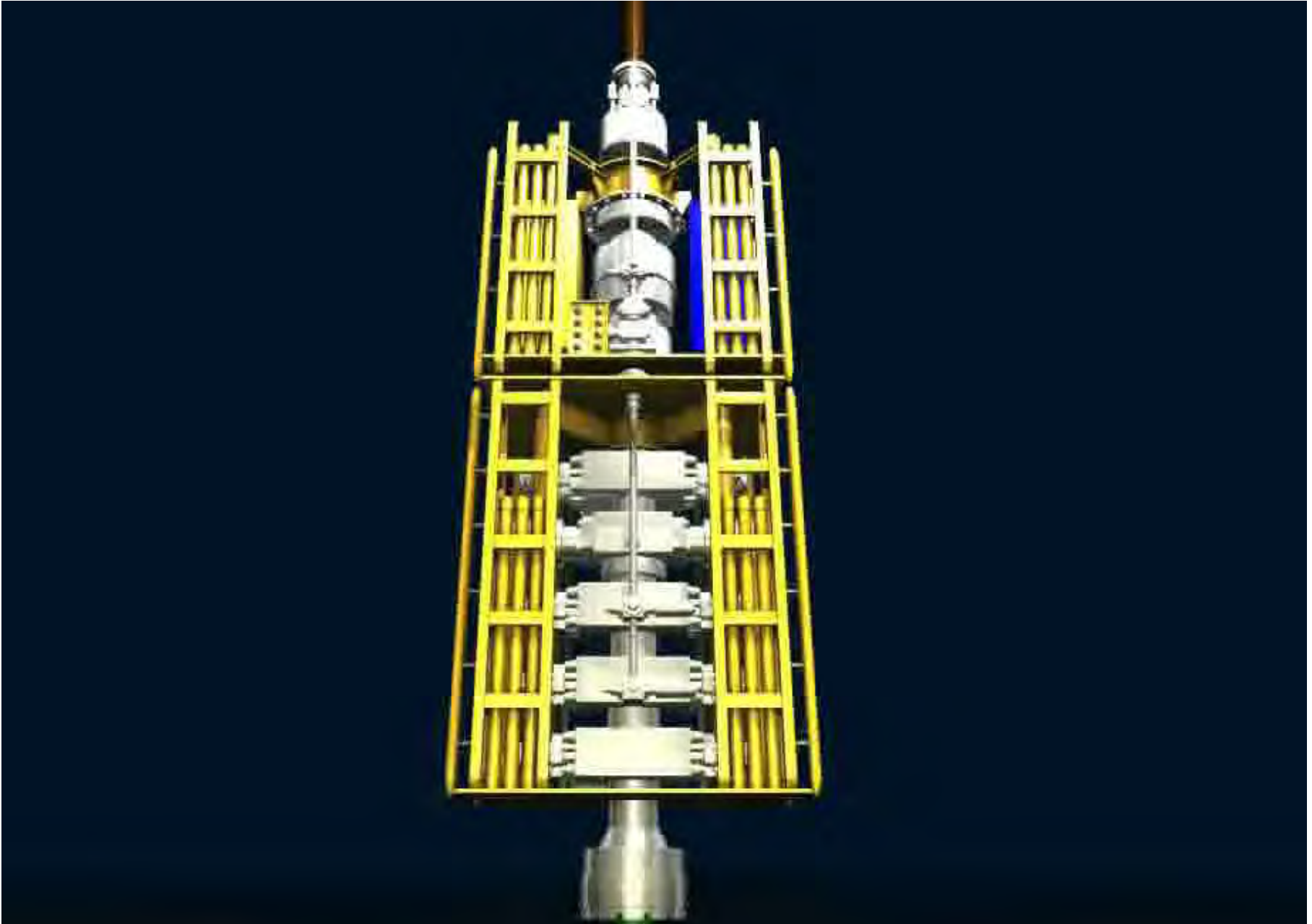


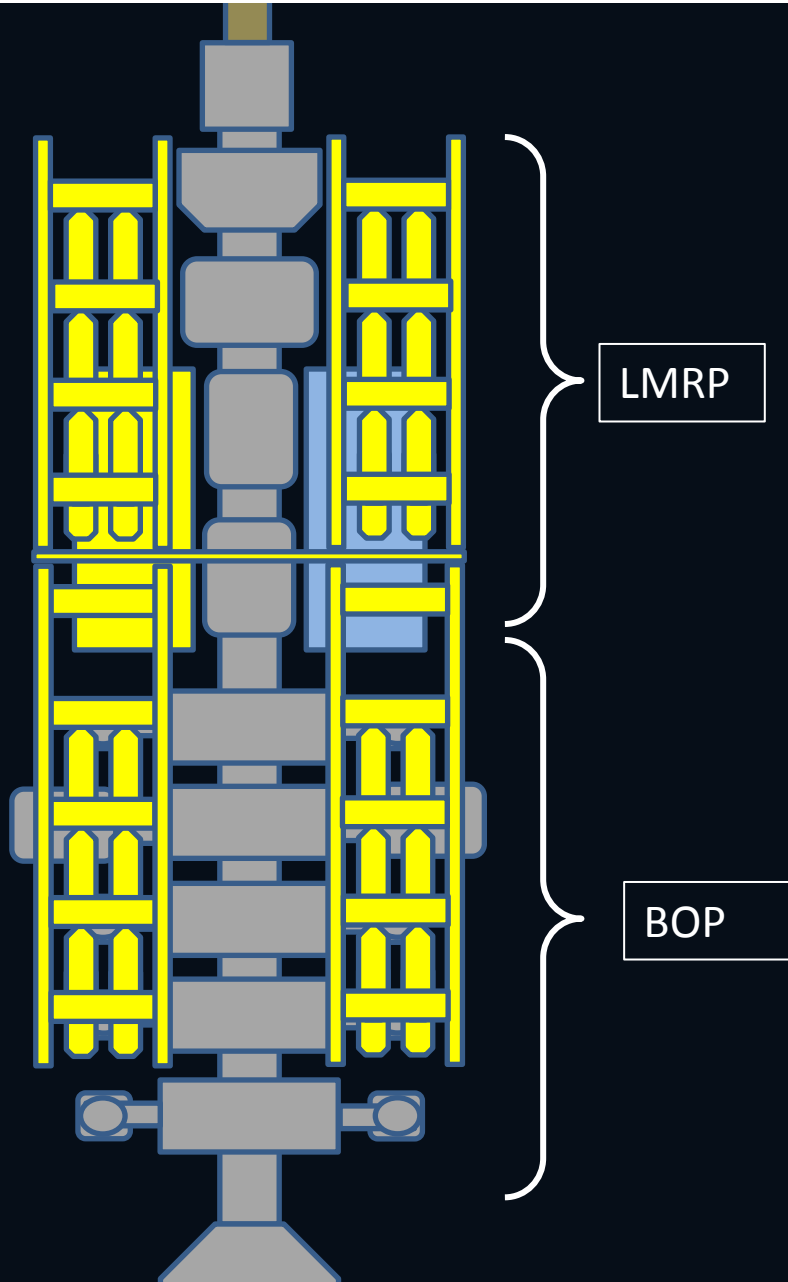
## Onshore BOP and Control Lines

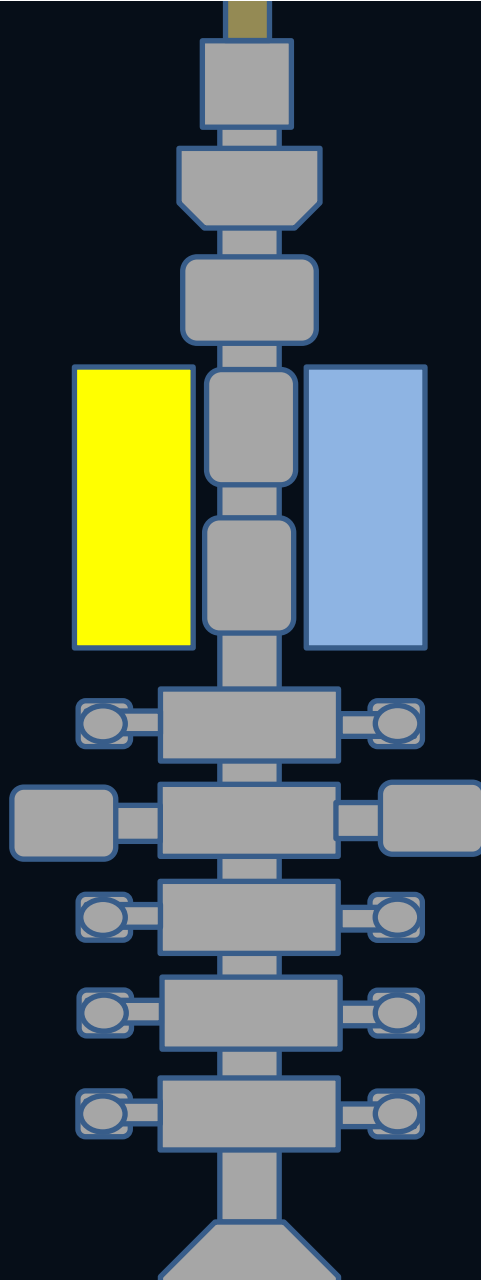


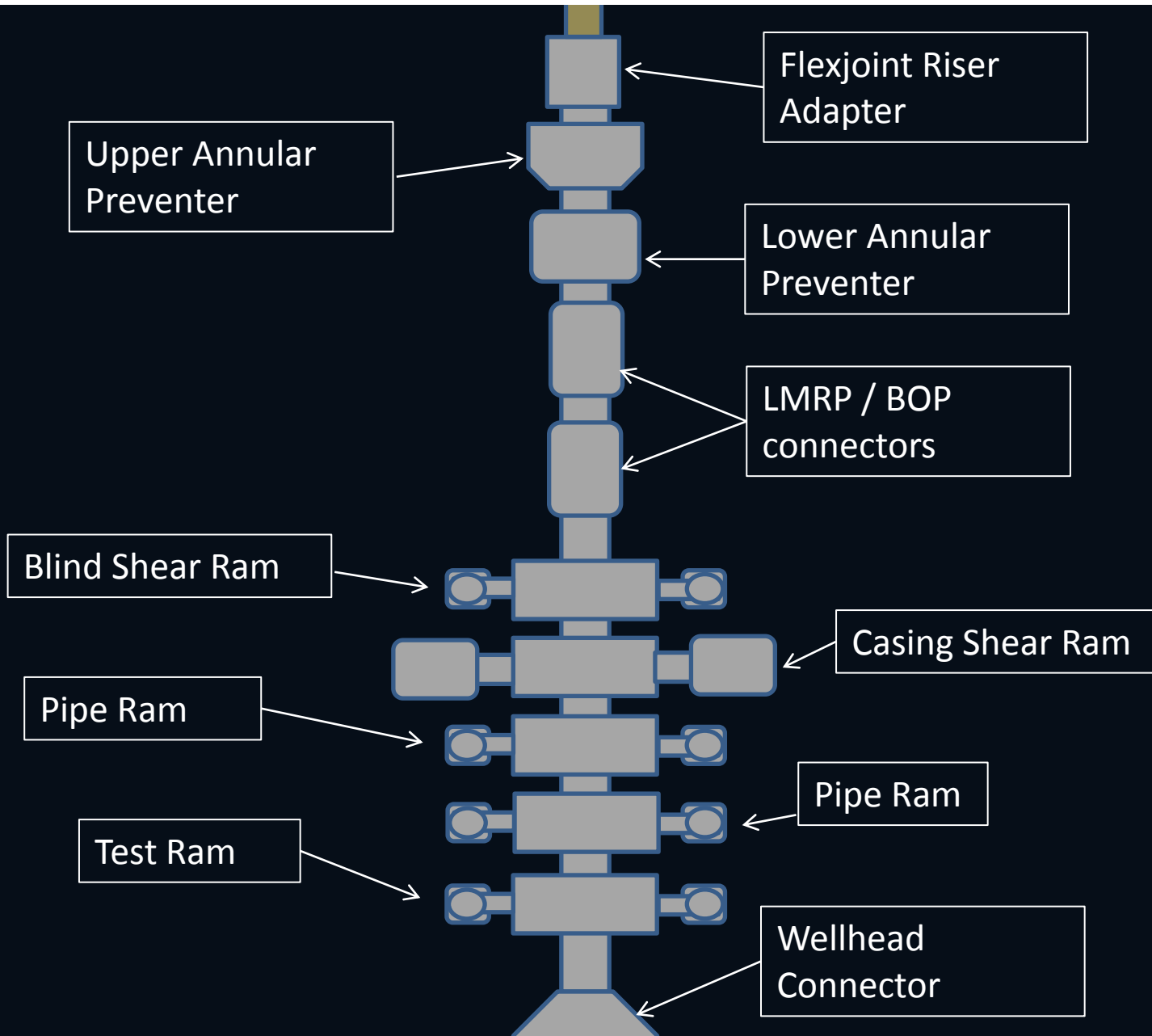
## BOP Control Systems

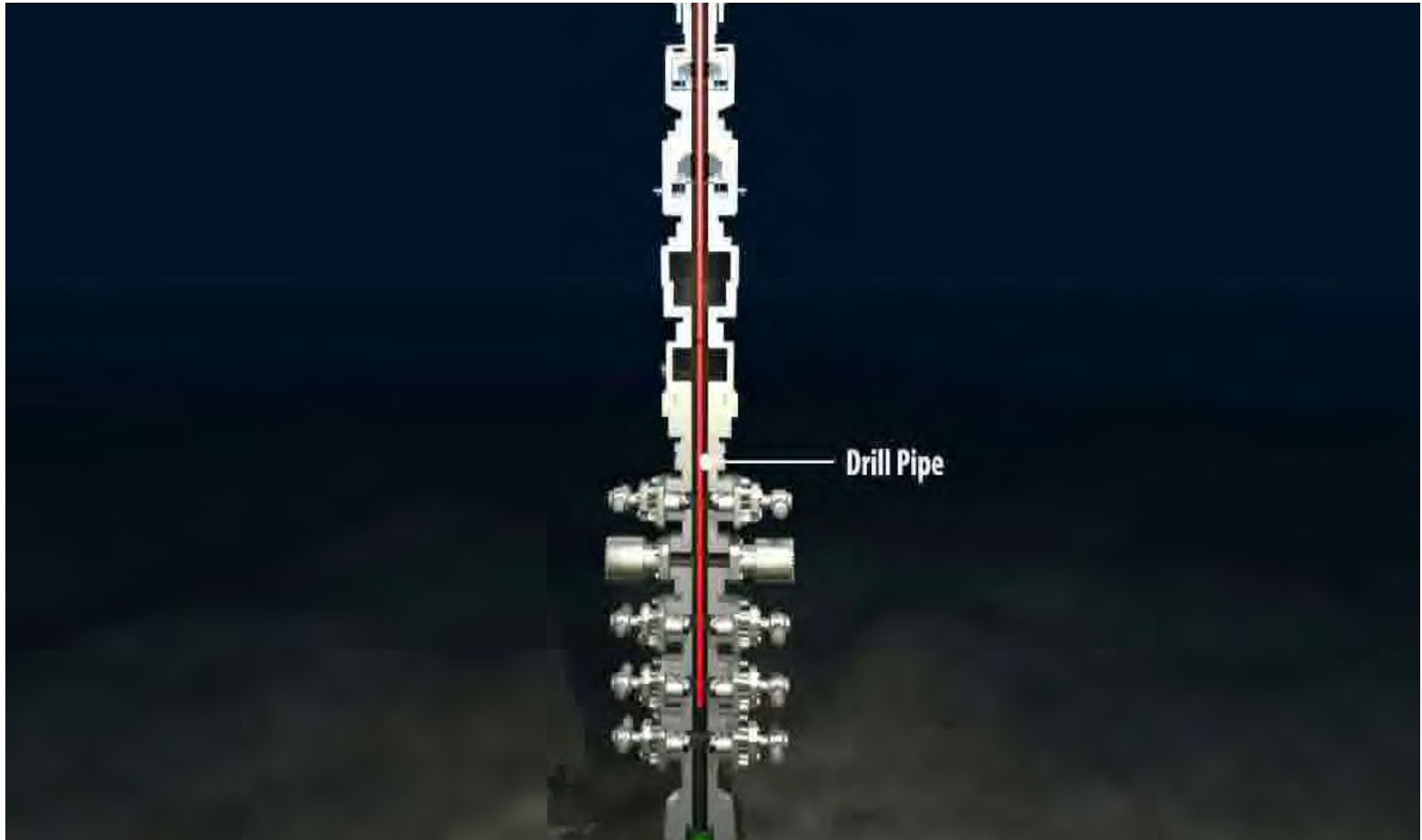
- The function of the control system is to ensure that hydraulic pressure is conveyed to the right place, at the correct pressure as quickly as possible
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- Offshore (from floating units) – things start to get a lot more complicated











## BOP Control Systems

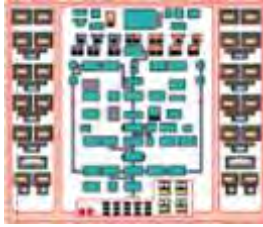
- The function of the control system is to ensure that hydraulic pressure is conveyed to the right place, at the correct pressure as quickly as possible
- Onshore – fairly basic system
- Offshore (from floaters) – things start to get more complicated
- Early offshore drilling from floaters – similar to onshore control systems

## BOP Control Systems

- As BOP activation response time increased with longer hoses in deeper water, designs developed to include a reservoir of pressurised hydraulic fluid stored sub-sea
- The pilot signals to operate the subsea control valves were initially transmitted hydraulically
- However, an instantaneous response time for the operation of the subsea control valves can be achieved using an electrical signal
- All modern deepwater BOPs use a multiplex control system

## BASIC MULTIPLEX SYSTEM

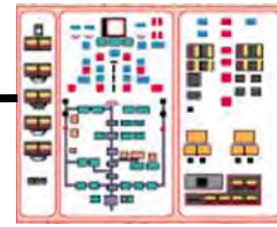
Driller's Panel



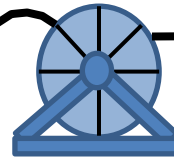
Central Control Unit



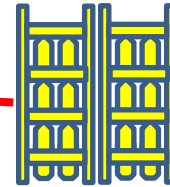
Toolpusher's Panel



MUX Cable Reel

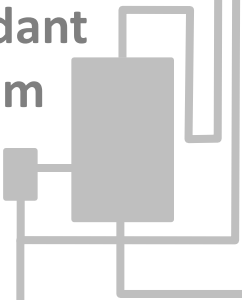


Surface Accumulators

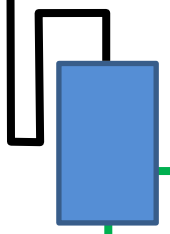


Hydraulic Fluid Reservoir and HPU

Redundant System



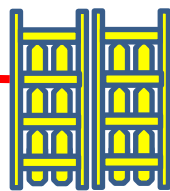
Active Pod



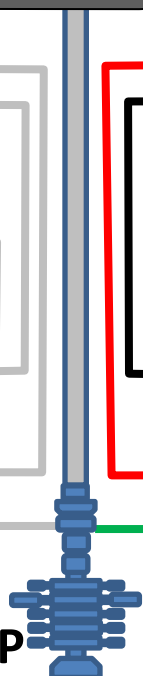
Regulator



Sub-sea Accumulators



BOP/LMRP



- Electrical Signal
- Accumulator Pressure
- Regulated Fluid Pressure

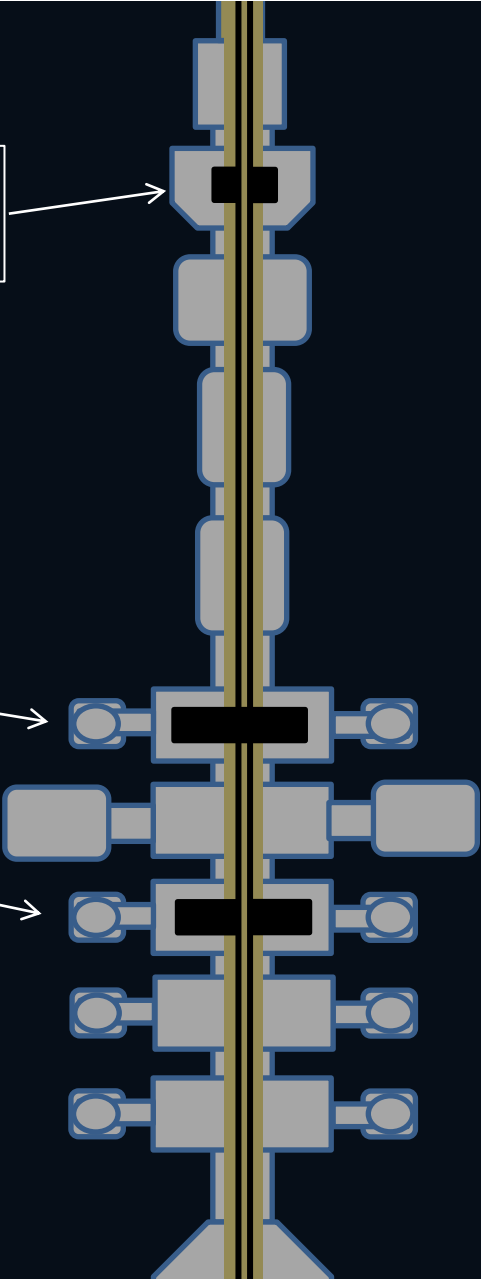
## BOP Control Systems

- During normal use, the BOP is operated from one of the rig control panels
- Whilst in drilling mode
  - Annular
  - Pipe Ram
  - Blind Shear Ram

Upper Annular  
Preventer

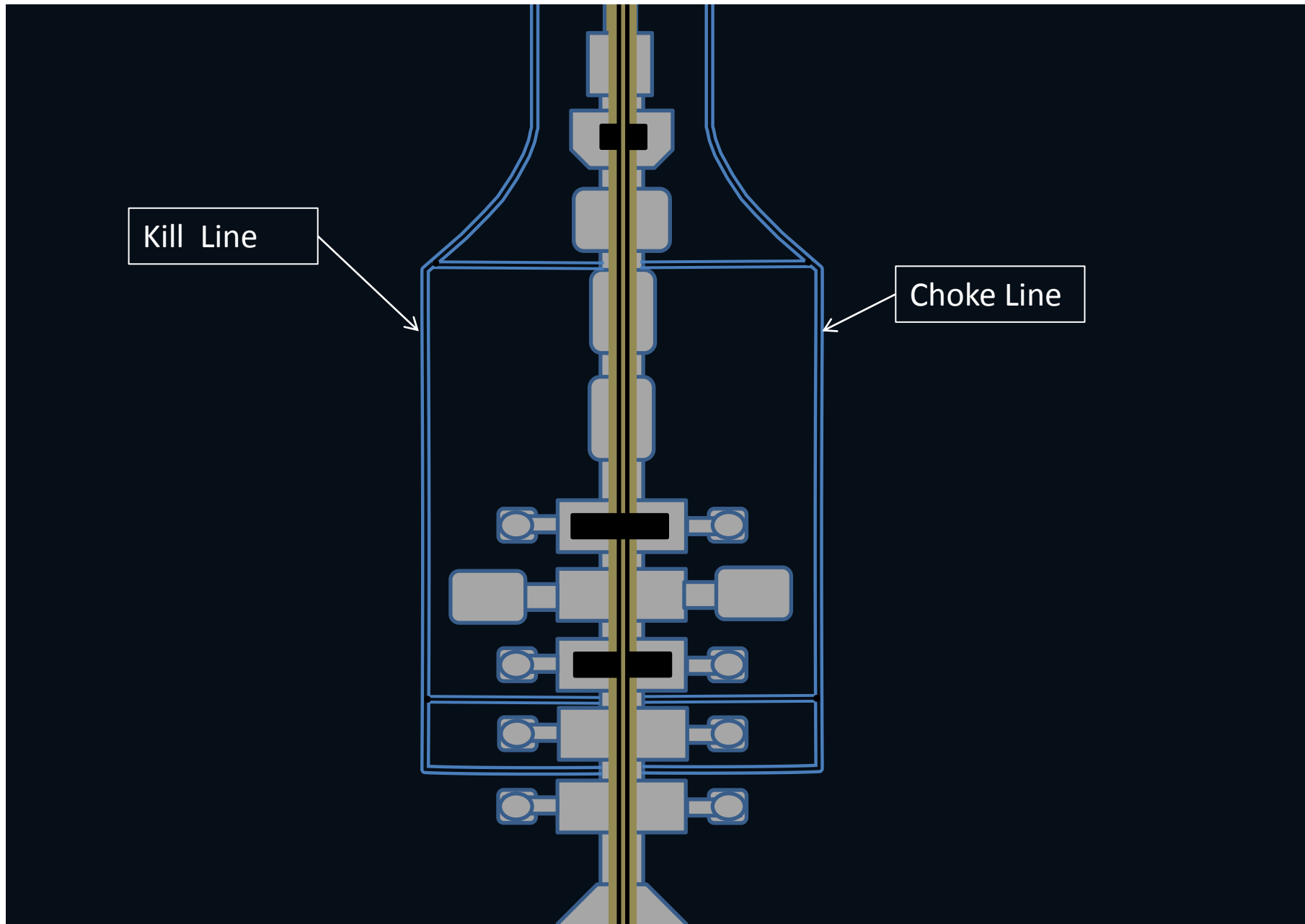
Blind Shear Ram

Pipe Ram



## BOP Control Systems

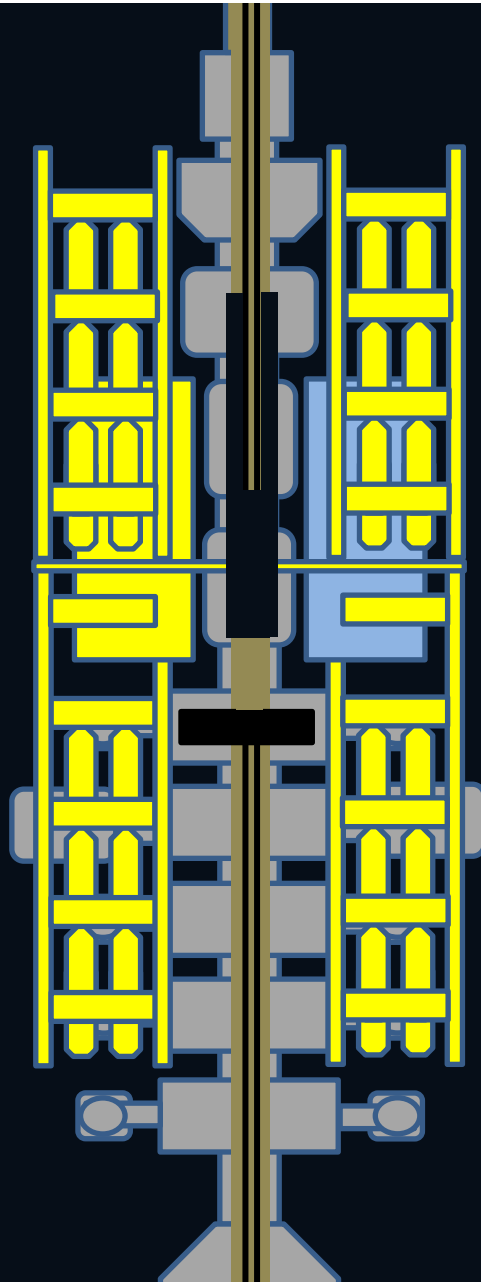
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  - Choke and kill line operations



## BOP Control Systems

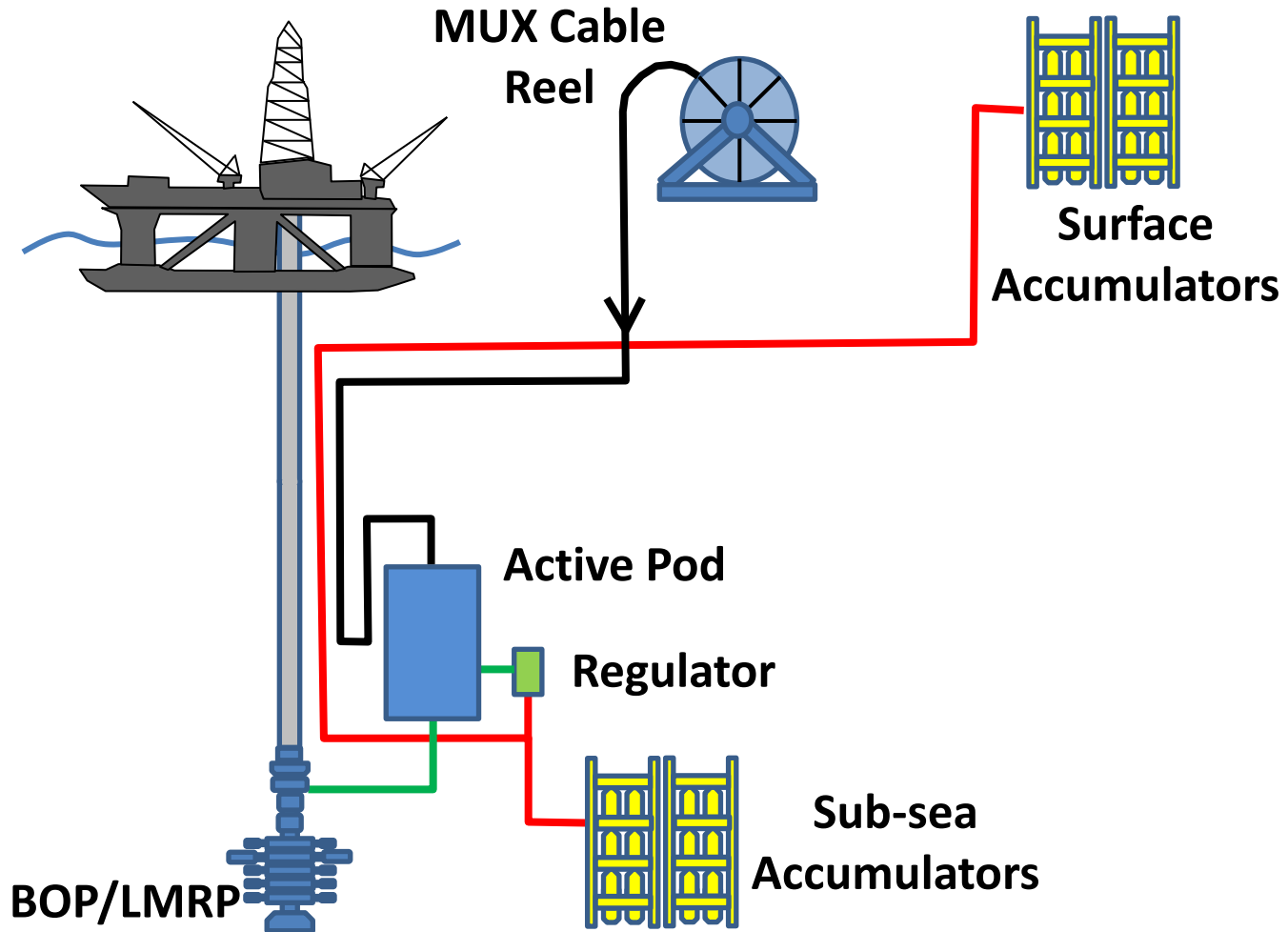
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  - Blind Shear Ram
  - Choke and kill line operations
- Emergency Modes
  - AutoShear / Emergency Disconnect Function

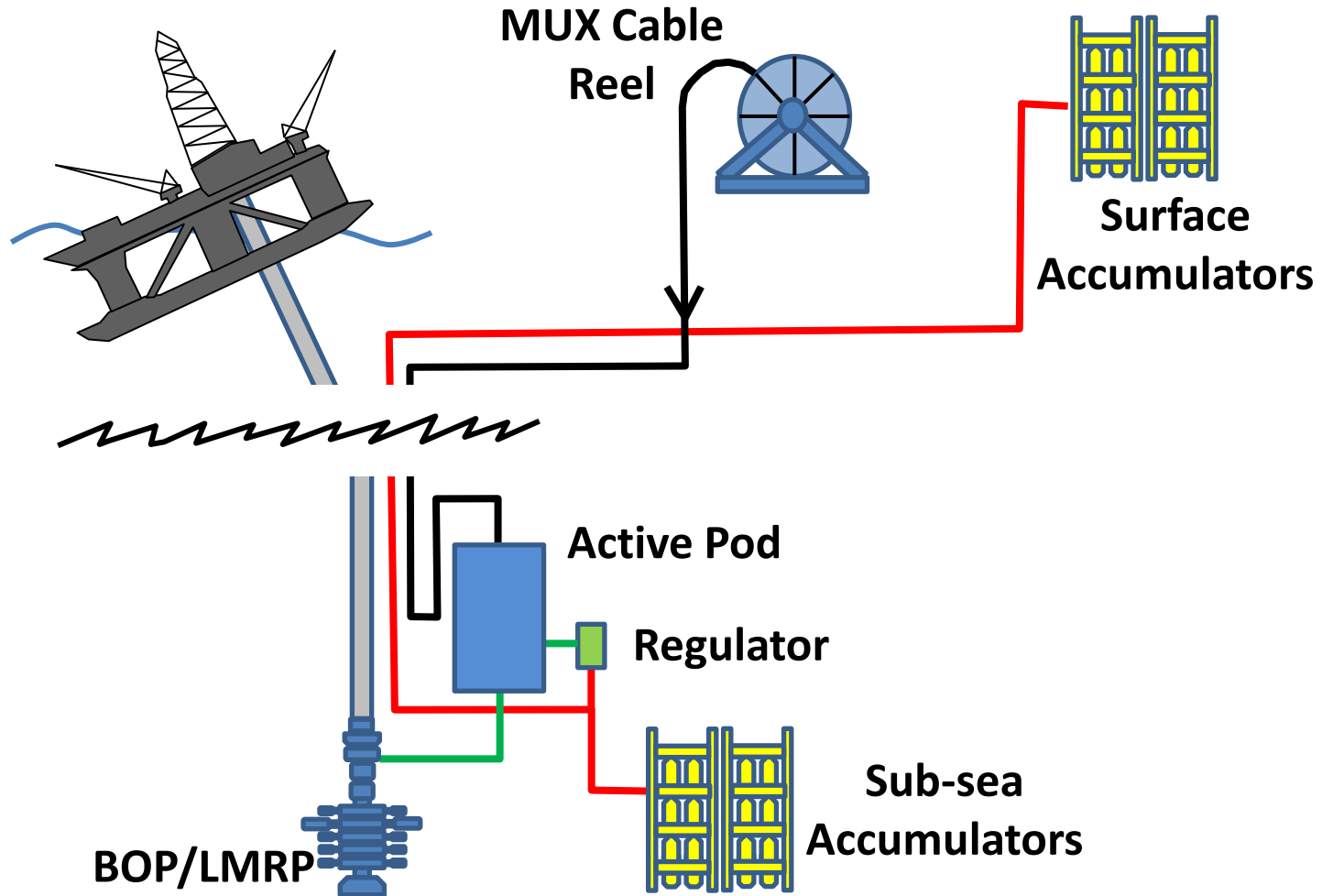
Blind Shear Ram



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  - Choke and kill line operations
- Emergency Modes
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  - Deadman





## BOP Control Systems

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- Whilst in drilling mode
  - Annular
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  - Blind Shear Ram
  - Choke and kill line operations
- Emergency Modes
  - AutoShear / Emergency Disconnect Function
  - Deadman
  - Acoustic

## Acoustic Emergency System

- Normally unaffected by damage to the primary system
- Surface transducers send signal to transceivers on the BOP
- Regulatory requirement in some areas
- Not always reliable

## BOP Control Systems

- During normal use, the BOP is operated from one of the rig control panels
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  - Annular
  - Pipe Ram
  - Blind Shear Ram
  - Choke and kill line operations
- Emergency Modes
  - AutoShear / Emergency Disconnect Function
  - Deadman
  - Acoustic
  - ROV intervention

## ROV Intervention Panel



## BOP Limitations and Reliability

- Maximum BOP pressure rating is struggling to keep pace with drilling technology
- Shear rams cannot cut through some drillstring components (e.g. drillpipe connections) or certain extraordinary obstructions in the bore of the BOP
- Routine full emergency testing of all functions is not deemed to be practicable
- Despite continuing R&D by the BOP manufacturers, component failures are random events and may still occur

## Summary of Component Testing Cycles over 5 Years

### **Component**

Accumulators

Check Valves

Pilot Check Valves

Pilot Valves, Dual Action

Pilot Valves, Single Action

Regulators

Shuttle Valves

Solenoid Valves



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## BOP Limitations and Reliability

- Maximum BOP pressure rating is struggling to keep pace with drilling technology
- Shear rams cannot cut through jointed drillpipe connections or certain extraordinary obstructions in the bore of the BOP
- Routine full emergency testing of all functions is deemed not practicable
- Despite continuing R&D by the BOP manufacturers and drilling contractors, component failures are random events and may still occur
- Despite all reasonable precautions, some events remain unseen

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Any Questions?

[www.matdan.com](http://www.matdan.com)

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