

Wellhead Maintenance

Surface well completion equipment



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- Bachelor's degree of Petroleum & Natural Gas Engineering 2012.
- Current Senior Process and Production Engineer at Suez Oil Co "SUCO" since 2014.
- Worked for Weatherford drilling international for 2 years as well drilling and completion engineer.
- Instructor for Oil & Gas Upstream and downstream courses at MTC Egypt, Egyptian syndicates of engineers, OGS & OPA.
- Member of SPE, AAPG, AACE, NACE, Environmental Geoscience.
- IWCF , HYSYS process modeling, Eclipse certified.



<https://bit.ly/2UFSgpn>



Course Agenda

- | | |
|--------------------------------------|----|
| ■ Well site Field Equipment | 01 |
| ■ Well completion functions | 02 |
| ■ Factor affecting completion design | 03 |
| ■ Completion Techniques | 04 |



01

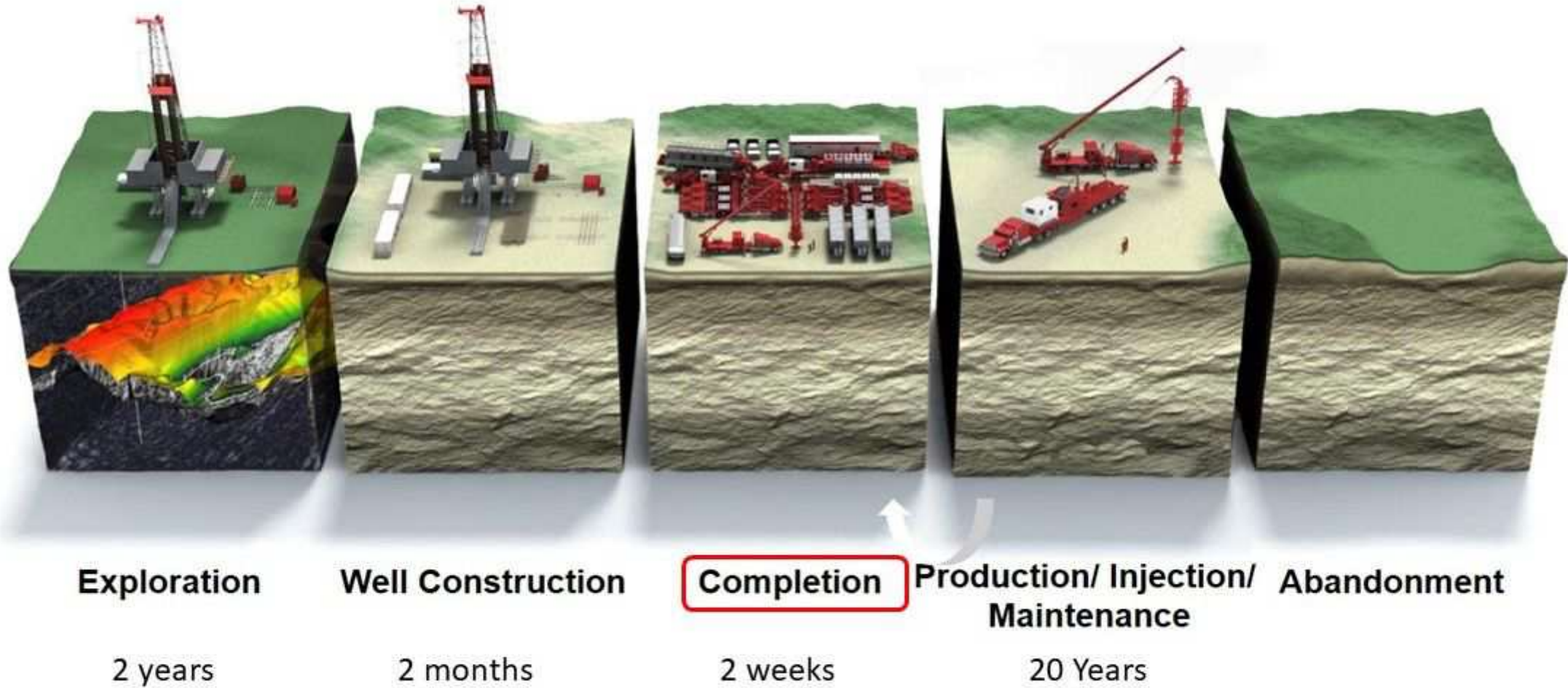
Well Site

Field Equipment



Well Life Cycle

Well completion Concepts











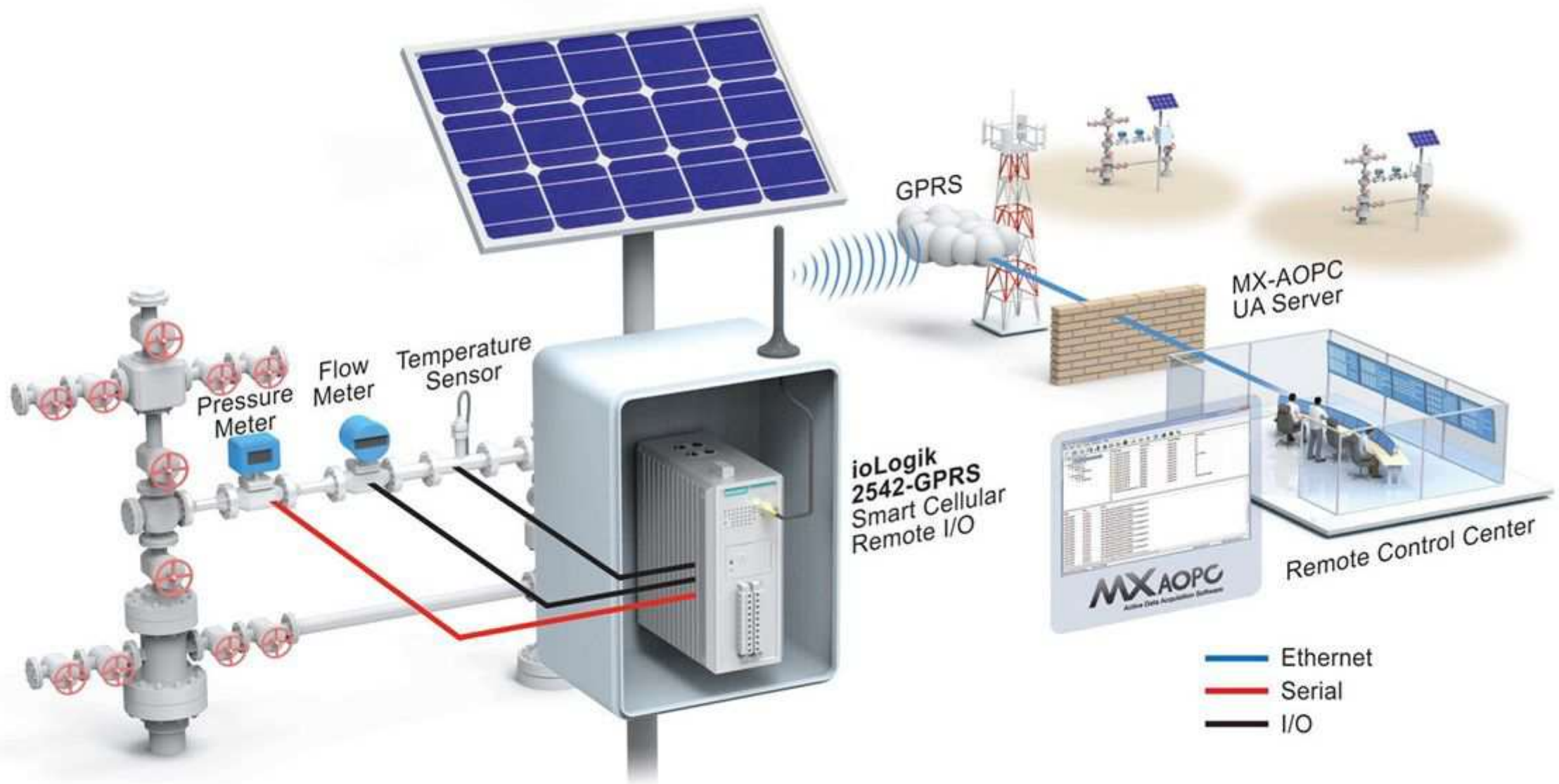


Wellhead Storage



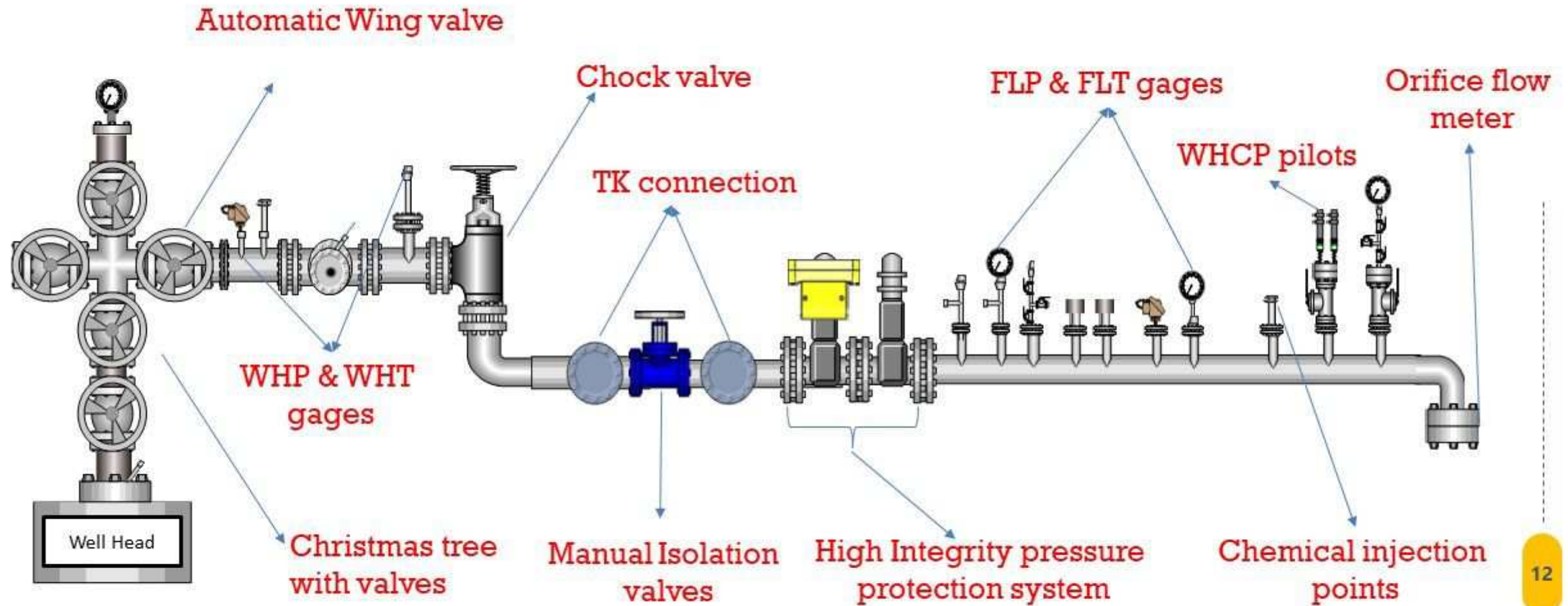


Remote Terminals RTU





Flow line valves and instrumentations



02

Surface

Well completion



Wellhead & Christmas tree

SURFACE WELLHEAD COMPLETION

Surface Completion equipment

1. Wellhead

2. Christmas tree or X-mass tree



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B Section

Christmas tree valves



A Section

Wellhead





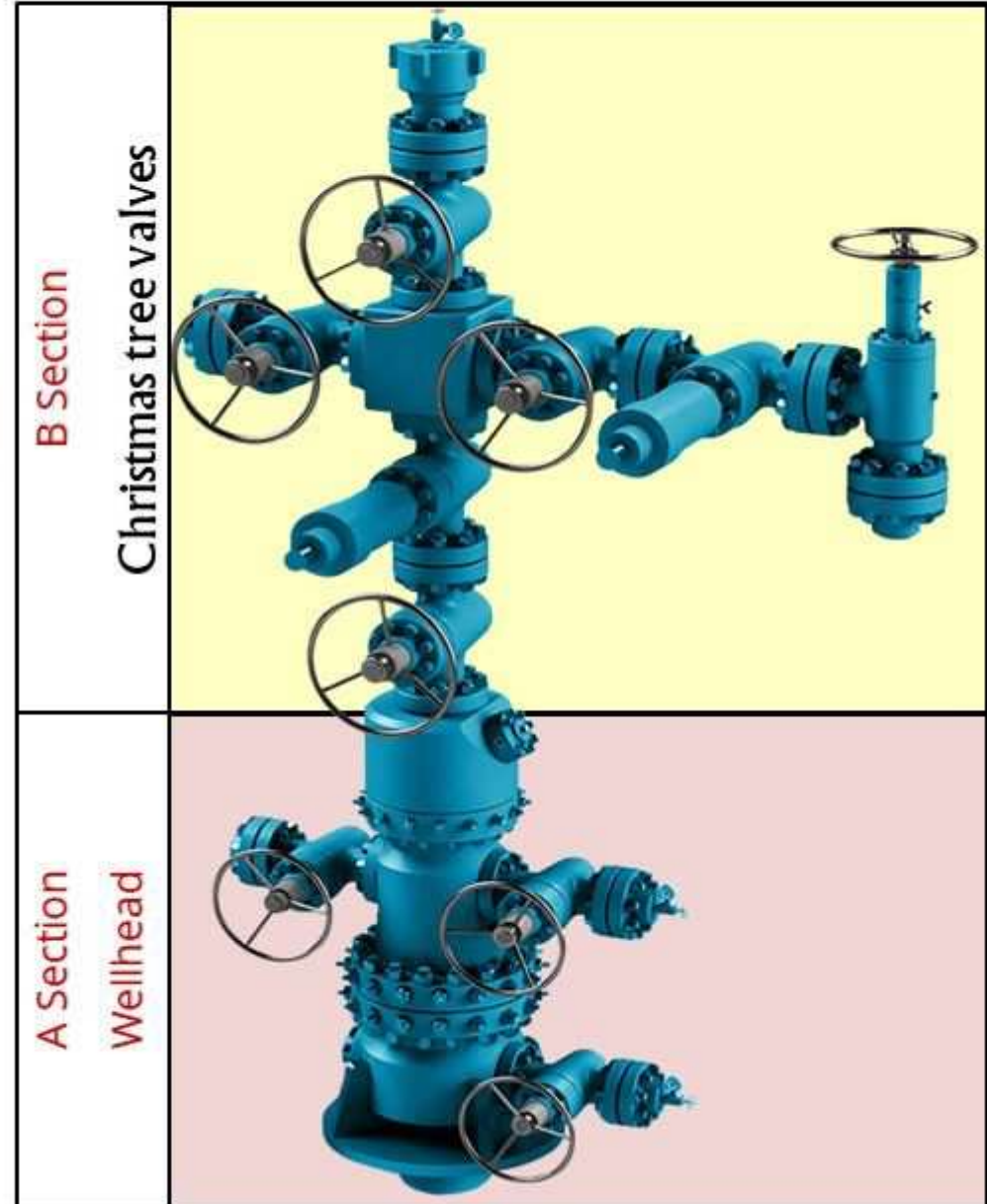
Wellhead & Christmas tree

SURFACE WELLHEAD COMPLETION

Surface Completion equipment

1. Wellhead

2. Christmas tree or X-mass tree

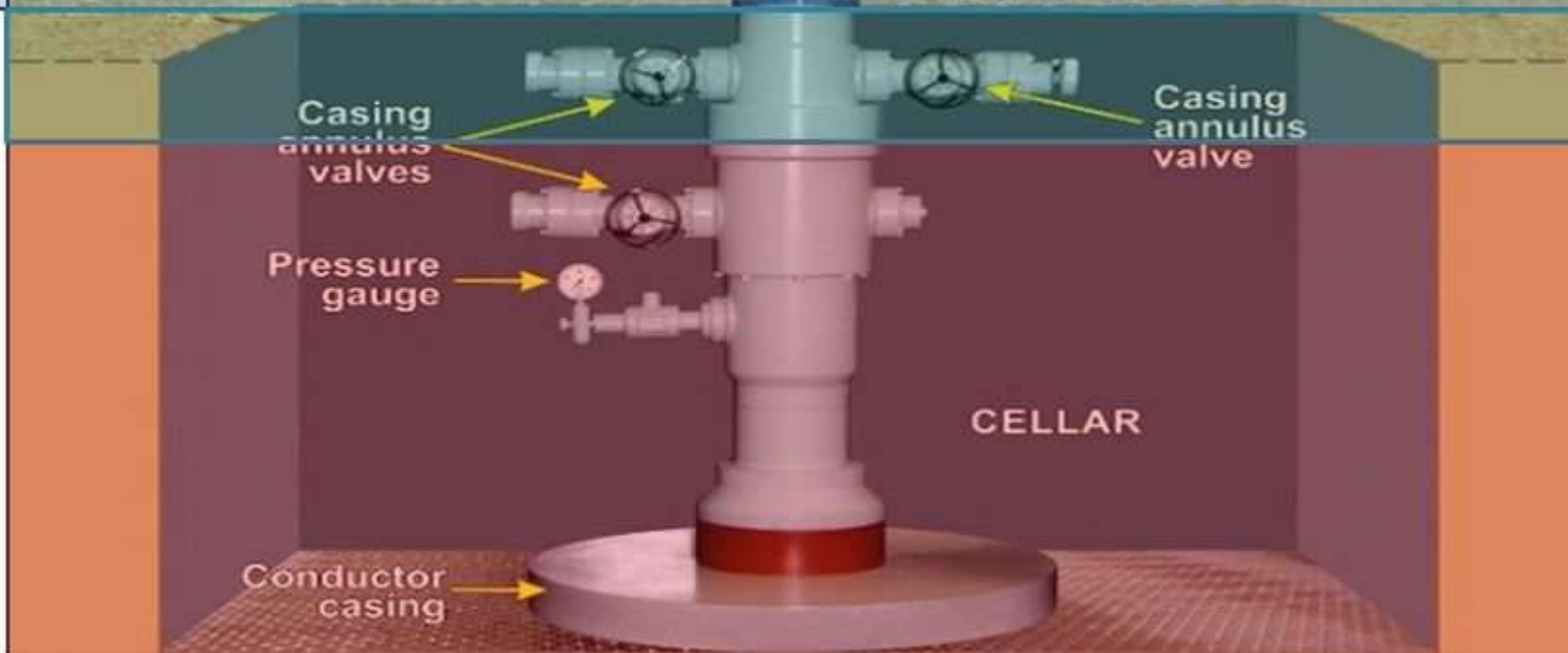


Christmas tree



Flow Control Equipment
X-mass tree valves

Wellhead



Tubing Suspension Equipment
Tubing head spool

Casing Suspension Equipment
Casing heads



Well Head - Definition

SURFACE WELLHEAD COMPLETION



The wellhead is a surface foundation on which the well is built-up during the drilling operations and is the base for the m-mass tree for production operations.

01 Functions of wellhead:

- Safe means of containing well pressures.
- Support for each casing string
- Support for the BOP assembly
- Sealing & monitoring access of annuli
- Support for the completion (tubing) string
- Support for the Xmas Tree



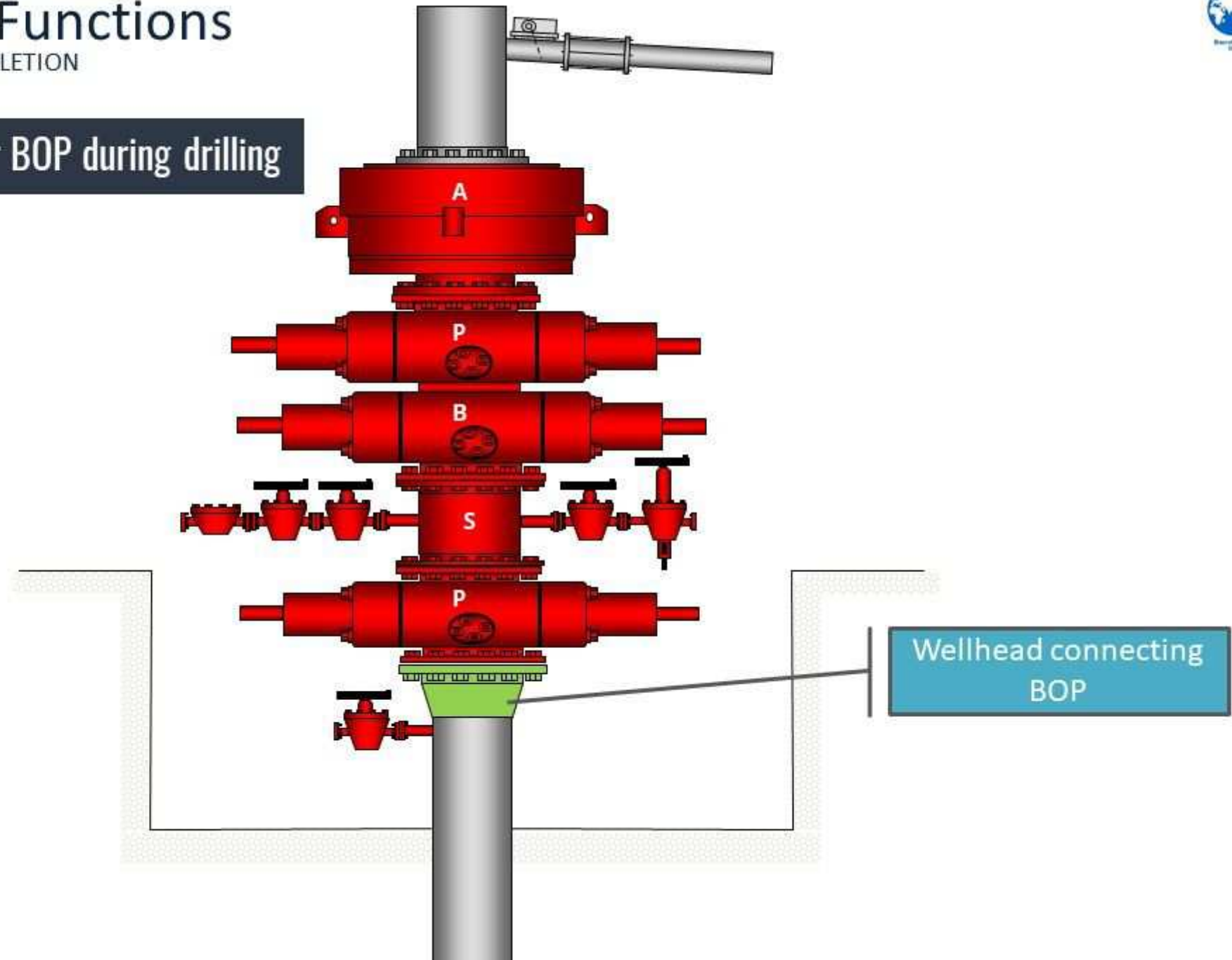


Well Head - Functions

SURFACE WELLHEAD COMPLETION



Provide connection for BOP during drilling





Well Head - Functions

SURFACE WELLHEAD COMPLETION



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Well Head - Functions

SURFACE WELLHEAD COMPLETION



Accommodate & suspend casing and tubing



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Well Head - Types

SURFACE WELLHEAD COMPLETION



Wellhead systems differ by well location:

- Land
- Surface locations offshore (jack up or platform)
- Subsea

Offshore wellhead systems are normally more sophisticated in design to handle ocean currents, bending loads, and other loads induced by the environment during the life of the well.





Well Head - Types

SURFACE WELLHEAD COMPLETION



Land Wellhead



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Well Head - Types

SURFACE WELLHEAD COMPLETION



offshore Wellhead

Dry



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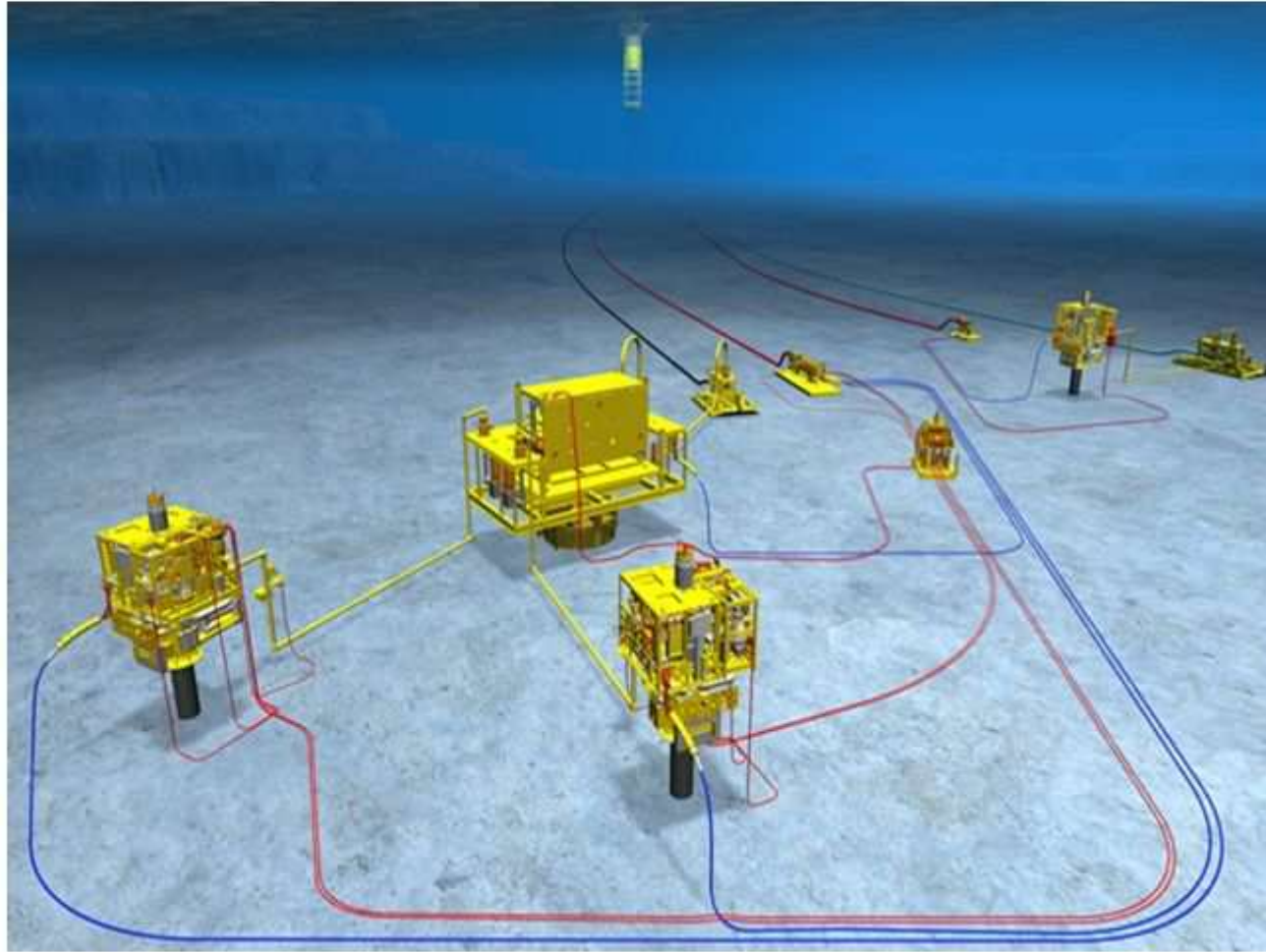
Well Head - Types

SURFACE WELLHEAD COMPLETION



Subsea Wellhead

Wet



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Christmas tree - Definition

SURFACE WELLHEAD COMPLETION



assembly of a multi-valved structure consisting of valves, spools, and fittings used to control the flow of oil from the well.

01 Functions of wellhead:

- Provides a means of fluid flow controlling.
- Ensuring the safety of surface facilities
- Provide measuring and Monitoring of well parameters
- Provide connection for Well intervention equipment:
 - Slickline
 - E-line
 - Coiled tubing





Christmas tree - Definition

SURFACE WELLHEAD COMPLETION

Uses of Christmas tree:

- Oil & Gas well,
- Water injection well,
- Water disposal well,
- Gas injection well,
- Condensate well,
- Artificial lift well



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Christmas tree

SURFACE WELLHEAD COMPLETION



Single Composite Tree (loose valves)





Christmas tree

SURFACE WELLHEAD COMPLETION

Low pressure x-mass tree



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High pressure x-mass tree





Christmas tree - Definition

SURFACE WELLHEAD COMPLETION



HPHT Wellhead-Tree 20,000 PSI / 300 C



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Christmas tree - Definition

SURFACE WELLHEAD COMPLETION



PCP x-mass tree





Christmas tree - Definition

SURFACE WELLHEAD COMPLETION



Plunger lifting tree



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Christmas tree - Definition

SURFACE WELLHEAD COMPLETION

ESP x-mass tree





Christmas tree - Definition

SURFACE WELLHEAD COMPLETION

Sucker rod x-mass tree



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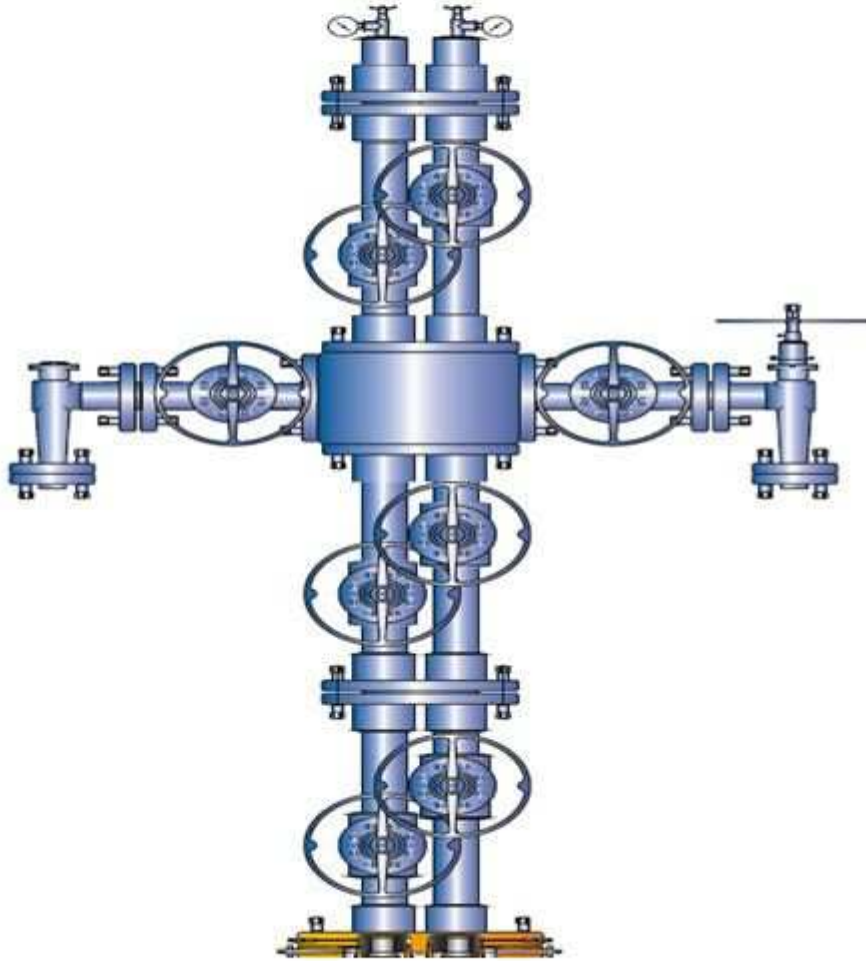




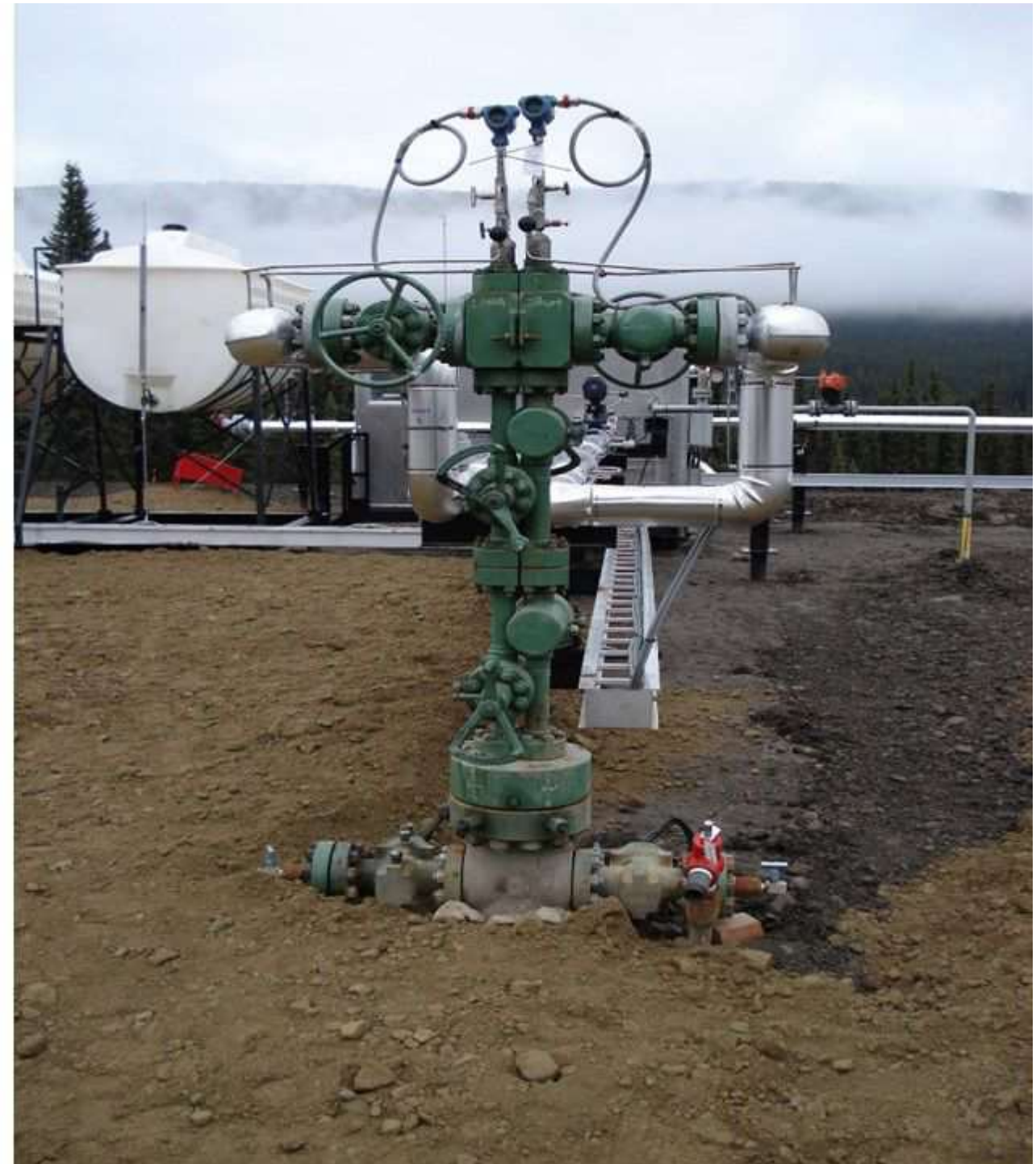
Christmas tree - Definition

SURFACE WELLHEAD COMPLETION

Dual tubing Christmas tree



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Christmas tree - Definition

SURFACE WELLHEAD COMPLETION



Single Solid Block tree



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Christmas tree - Definition

SURFACE WELLHEAD COMPLETION

Y shape Solid Block tree

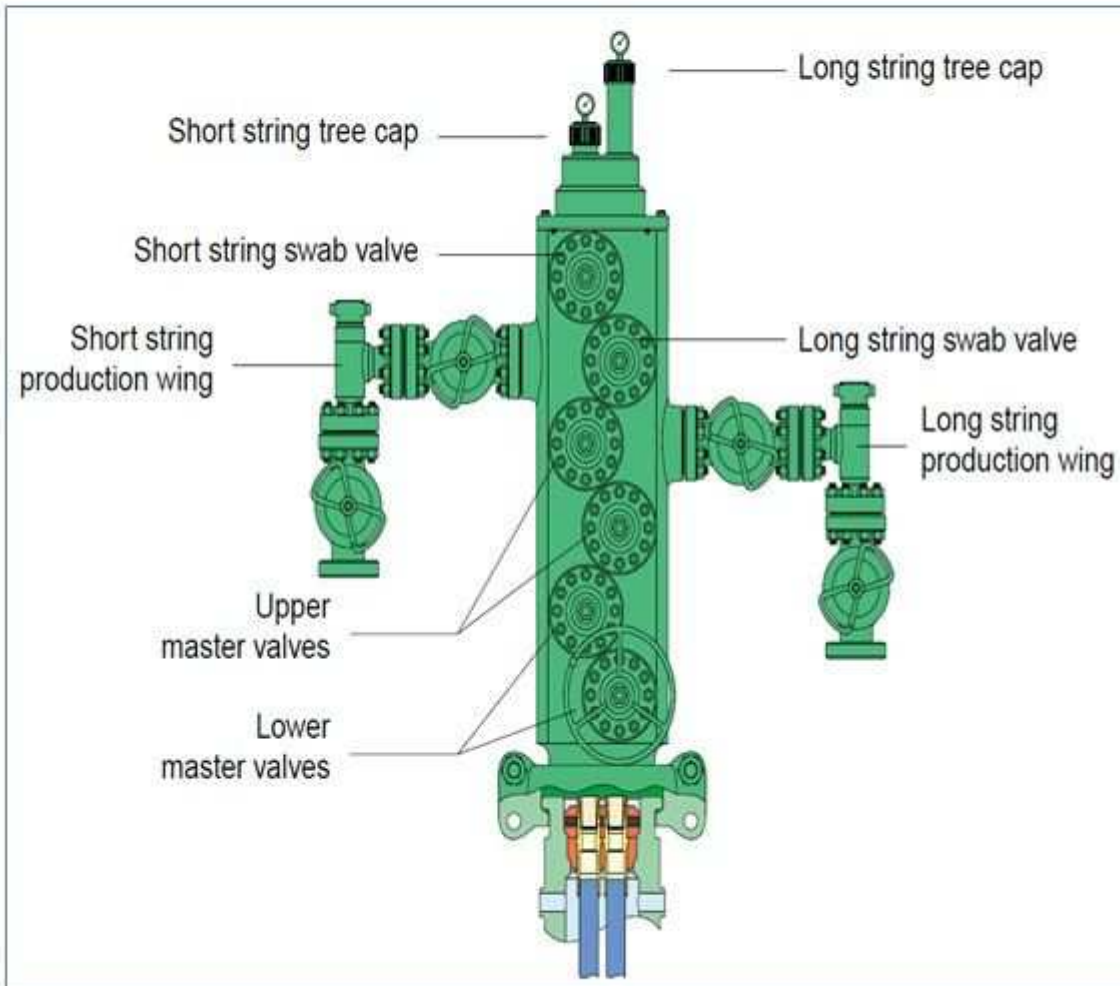




Christmas tree - Definition

SURFACE WELLHEAD COMPLETION

Dual Solid Block tree



integrated wellhead





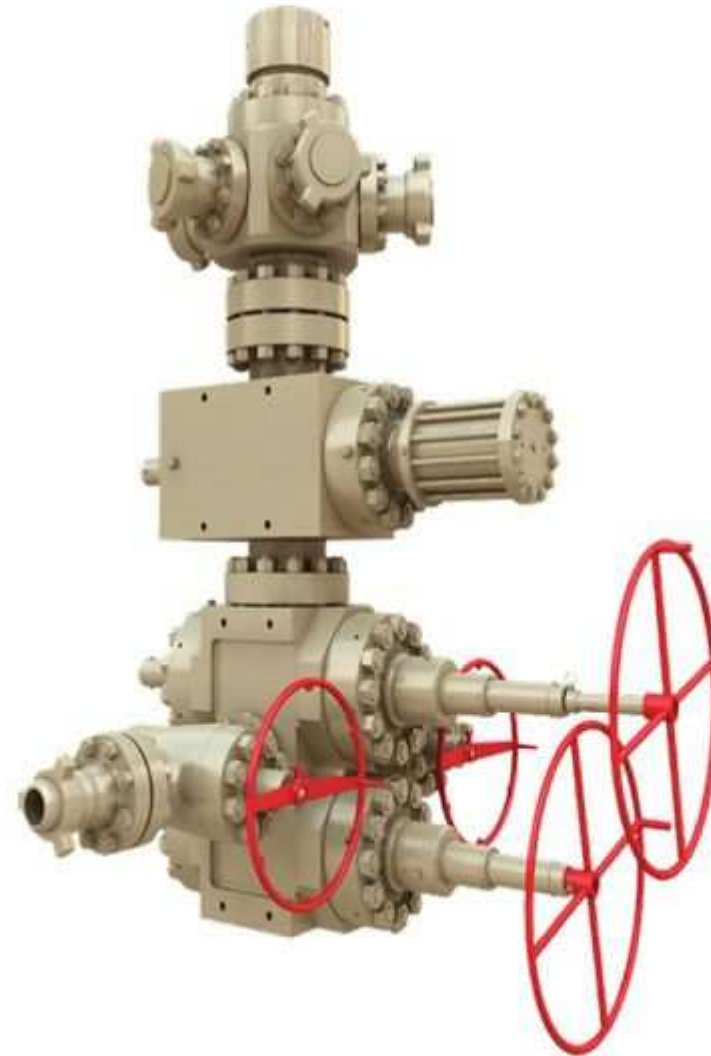
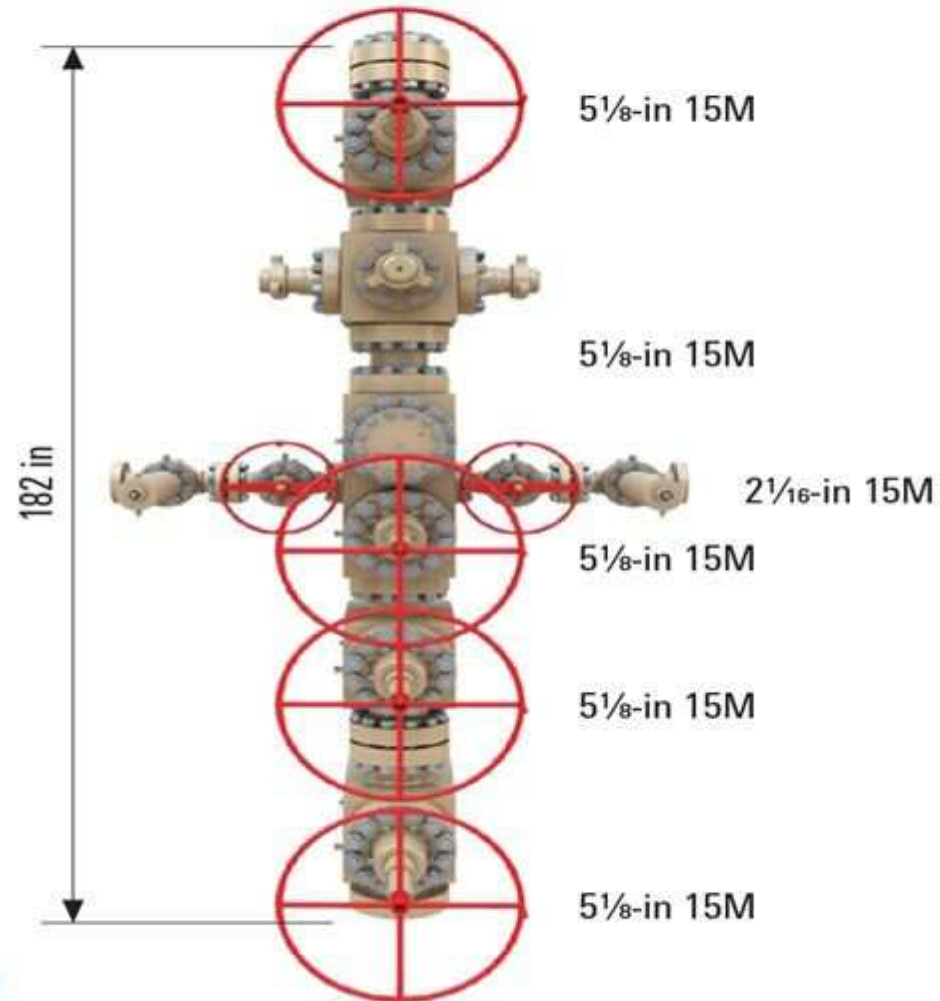
Christmas tree - Definition

SURFACE WELLHEAD COMPLETION



Composite frac tree.

Designed for hydraulic fracturing pressures up to 15,000 psi,



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03

Wellhead & X-mass tree

Selection and design



Wellhead equipment suppliers

Design and selection



- Major manufacturers, suppliers, and vendors of wellhead equipment and X-mass trees are:

**BAKER
HUGHES**
a GE company



 **CAMERON**
A Schlumberger Company



FMC
Technologies


DELTA



 **Cactus**
Wellhead





Wellhead equipment materials

Design and selection



Two parameters should be considered when selecting a wellhead material :

- Produced fluid properties
- Maximum operating temperature



API 6A-0731



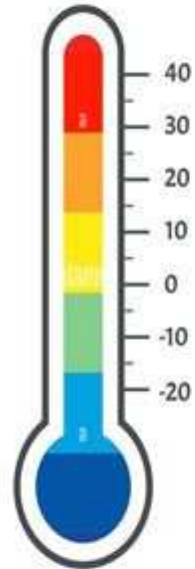


Wellhead equipment materials

Design and selection



1. Rating Temperature



■ Defines the application limits within a class to which corresponds the choice of steel grades.

■ A wellhead must commonly meet a number of temperature classes simultaneously and therefore the relevant materials must be chosen with great care.

API TEMP CLASS	OPERATING RANGE (DEG. F)			OPERATING RANGE (DEG. C)		
	(MIN.)		(MAX.)	(MIN.)		(MAX.)
K	-75	TO	180	-60	TO	82
L	-50	TO	180	-46	TO	82
N	-50	TO	140	-46	TO	60
P	-20	TO	180	-29	TO	82
R	ROOM TEMPERATURE			ROOM TEMPERATURE		
S	0	TO	140	-18	TO	60
T	0	TO	180	-18	TO	82
U	0	TO	250	-18	TO	121
V	35	TO	250	2	TO	121





Wellhead equipment materials

Design and selection



2. Rating Pressure



- Working Pressure (WP) is defined as the highest pressure at which the wellhead will be subjected during its working life.
- Six pressure ratings from 2,000 to 20,000 psi represent the maximum working pressure of the equipment

API Pressure Rating, psi [MPa]

2,000 [13.8]

3,000 [20.7]

5,000 [34.5]

10,000 [69.0]

15,000 [103.5]

20,000 [138.0]





Wellhead equipment materials

Design and selection



2. Rating Pressure

Max cold-working Pressure, psi	Hydrostatic Test Pressure
960	1440
2000	4000
3000	6000
5000	10000
10000	15000
15000	22500



So a 15000 psi Christmas tree means that the maximum operating pressure to which the tree should be subjected is 15000 psi even though the test pressure of the tree had been 22500 psi.



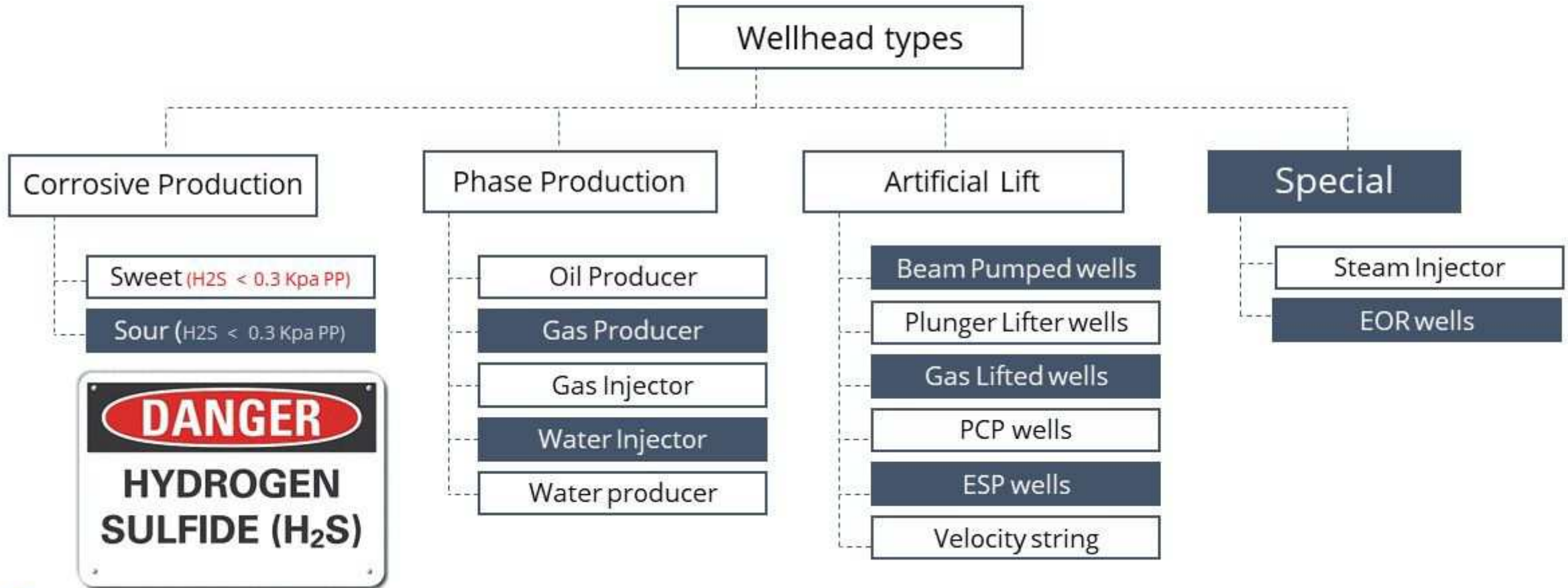


Wellhead equipment materials

Design and selection



- Each well types will create different requirements in terms of wellhead design.





Wellhead equipment materials

Design and selection



- Seven material classes Defines the steel corrosion resistance required

API Material Class	Body, Bonnet, End & Outlet Connections	Pressure Controlling Parts, Stems, & Mandrel Hangers
AA- General Service	Carbon or low alloy steel	Carbon or low alloy steel ^b
BB- General Service	Carbon or low alloy steel	Stainless Steel
CC- General Service	Stainless Steel	Stainless Steel
DD- Sour Service ^a	Carbon or low alloy steel ^b	Carbon or low alloy steel ^b
EE- Sour Service ^a	Carbon or low alloy steel ^b	Stainless steel
FF- Sour Service ^a	Stainless steel ^b	Stainless steel ^b
HH- Sour Service ^a	Corrosion Resistant Alloy ^b	Corrosion Resistant Alloy ^b
ZZ- Sour Service	User Defined ^b	User Defined ^b





Wellhead equipment materials

Design and selection



- Product Specification Levels (PSL)
 - Consists of a range of values (from 1 to 4) which defines all of the quality controls to which the materials must be subjected during design, construction and testing.
 - The highest value is that applied for the most severe installation conditions. The PSL of the equipment is based on a logical process that evaluates the predicted working pressure and the hydrogen sulfide (H₂S) content, since this compound is highly corrosive for steels and lethal to humans.



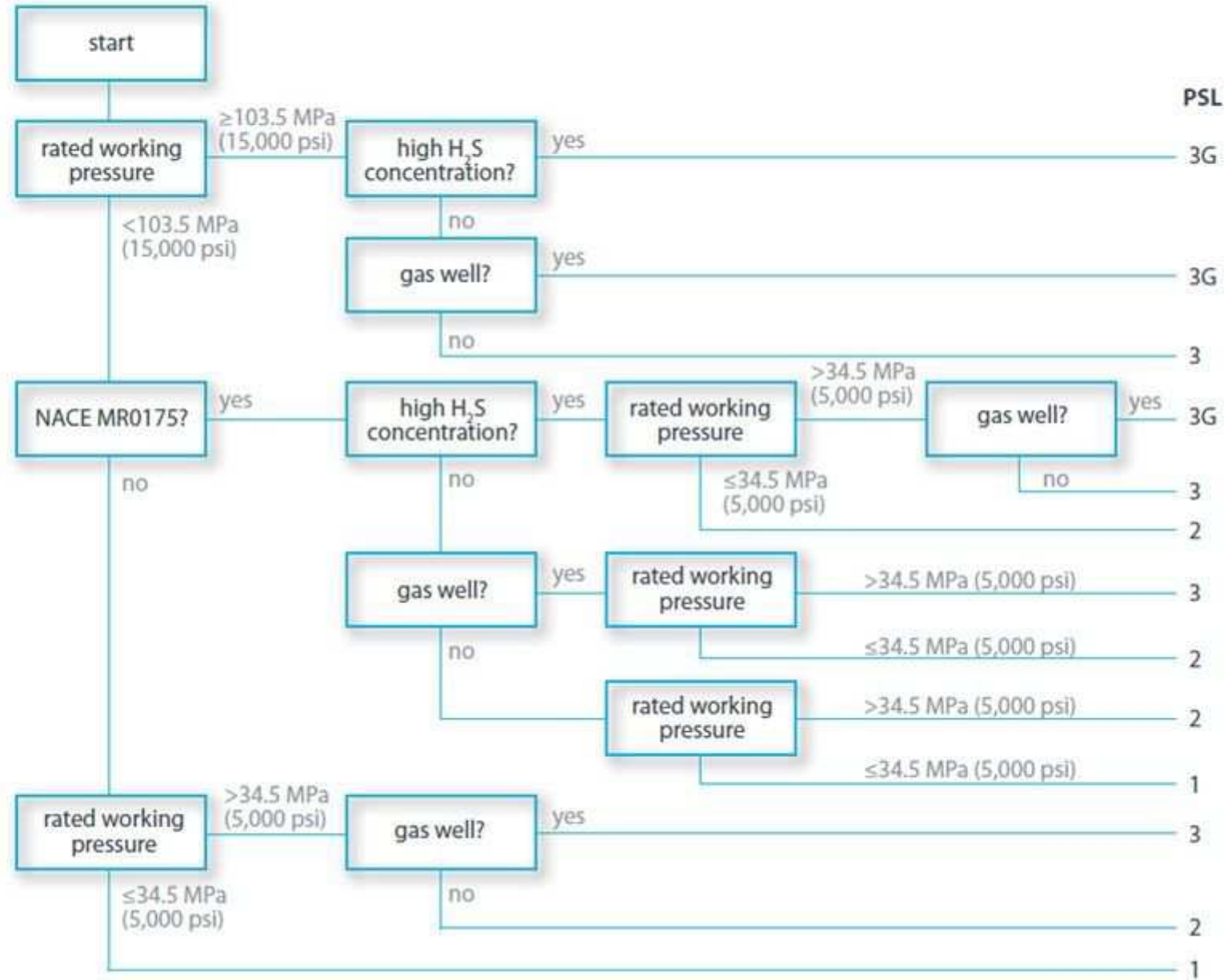


Wellhead equipment materials

Design and selection



■ PSL



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04

Wellhead Assembly



Wellhead Components

Wellhead assembly

Components of wellhead

■ Casing head	01
■ Casing hangers	02
■ Tubing head	03
■ Tubing hangers	04
■ Tubing adaptor	04



Tubing head



Casing spool



Casing hanger



Casing head



Base Plate





Wellhead Components

Wellhead assembly

Hole Size

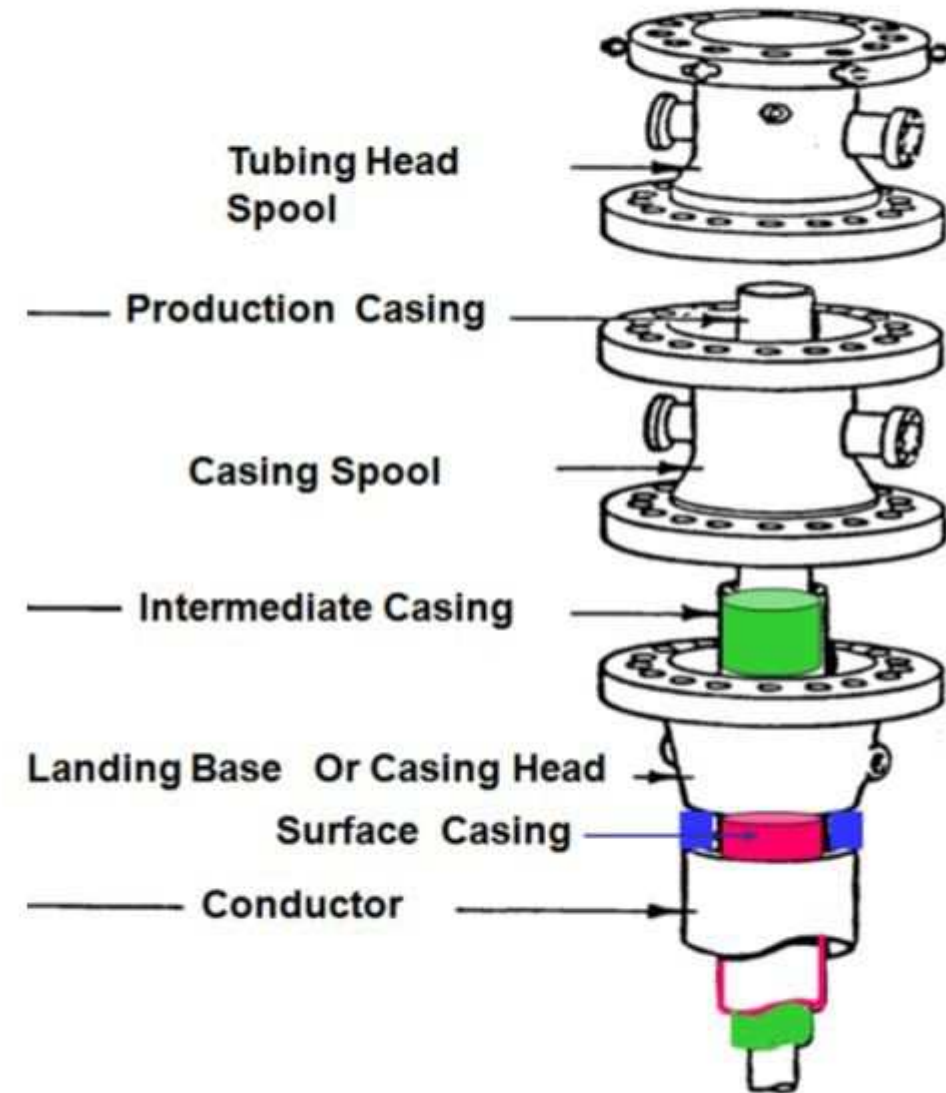
- 30"
- 23"
- 17 ½"
- 12 ¼"
- 8 ½"

Casing Size

26"
20" or 18 5/8"
13 3/8"
9 5/8"
7"

Casing Name

Conductor
Surface
Intermediate
Production
Production Liner





Wellhead Components

Wellhead assembly

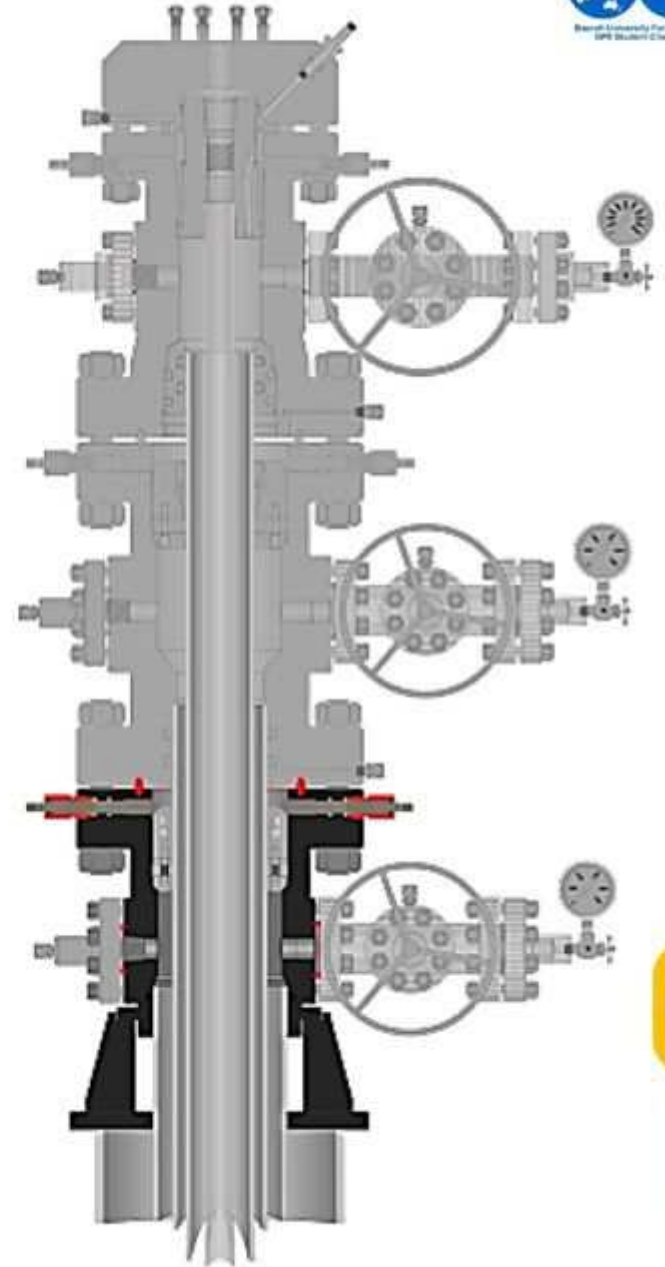


A. Casing Head

- A simple metal **flange welded** or **screwed** onto the top of the **conductor** pipe or the casing and forms part of the wellhead system.

Functions of casing head

1. Support the blowout preventer to the first casing.
2. Support the above-ground well completion;
3. Support the next, smaller casing
4. Seal the annular space between the two casing.
5. Ensure access to the annulus.





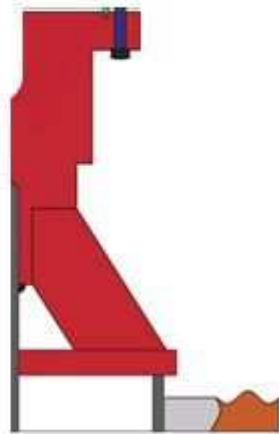
Wellhead Components

Wellhead assembly

A. Casing Head

Known as

1. "A-Section"
2. Lower casing head
3. Casing Housing
4. **Braden Head**
5. **Starter Head**



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Wellhead Components

Wellhead assembly



A. Casing Head

Bottom Connection



Weld Type



Threaded



SLIP



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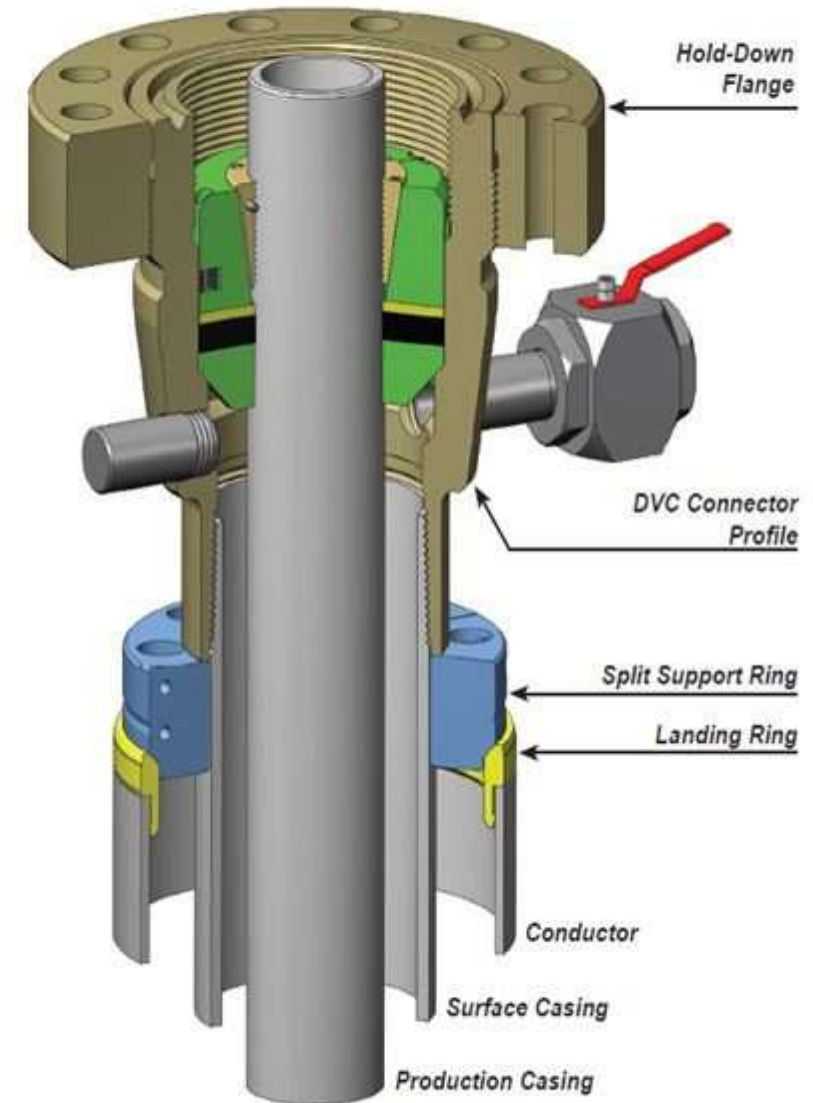
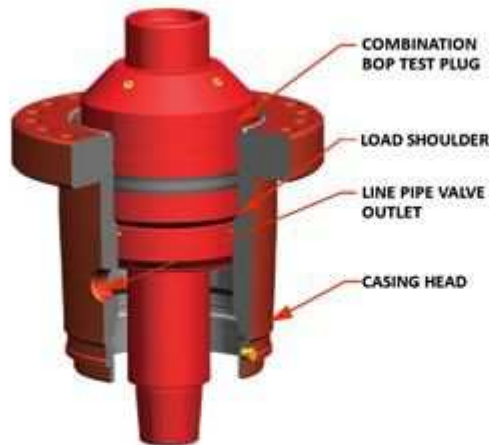
Wellhead Components

Wellhead assembly



B. Casing Hanger

- Casing hangers attached to the top of casing string,
- Suspends the casing load.
- Center the casing string in the head (or spool)
- Seals off the casing annulus





Wellhead Components

Wellhead assembly

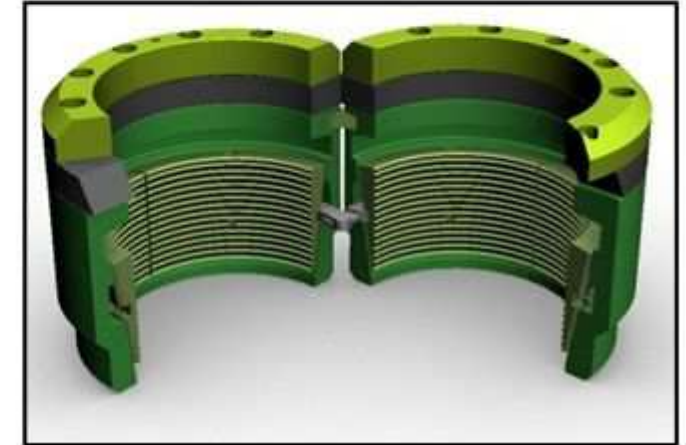


B. Casing Hanger

Casing hangers come in two main varieties:

1. Slip type hangers

- Installed around the casing after it is run,
- Either before or after the casing is cemented into place.



2. Mandrel type hangers

- Hangers threaded onto the casing.
- provide superior well control when landing the hanger and improve the annular seal.



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Wellhead Components

Wellhead assembly



B. Casing Hanger



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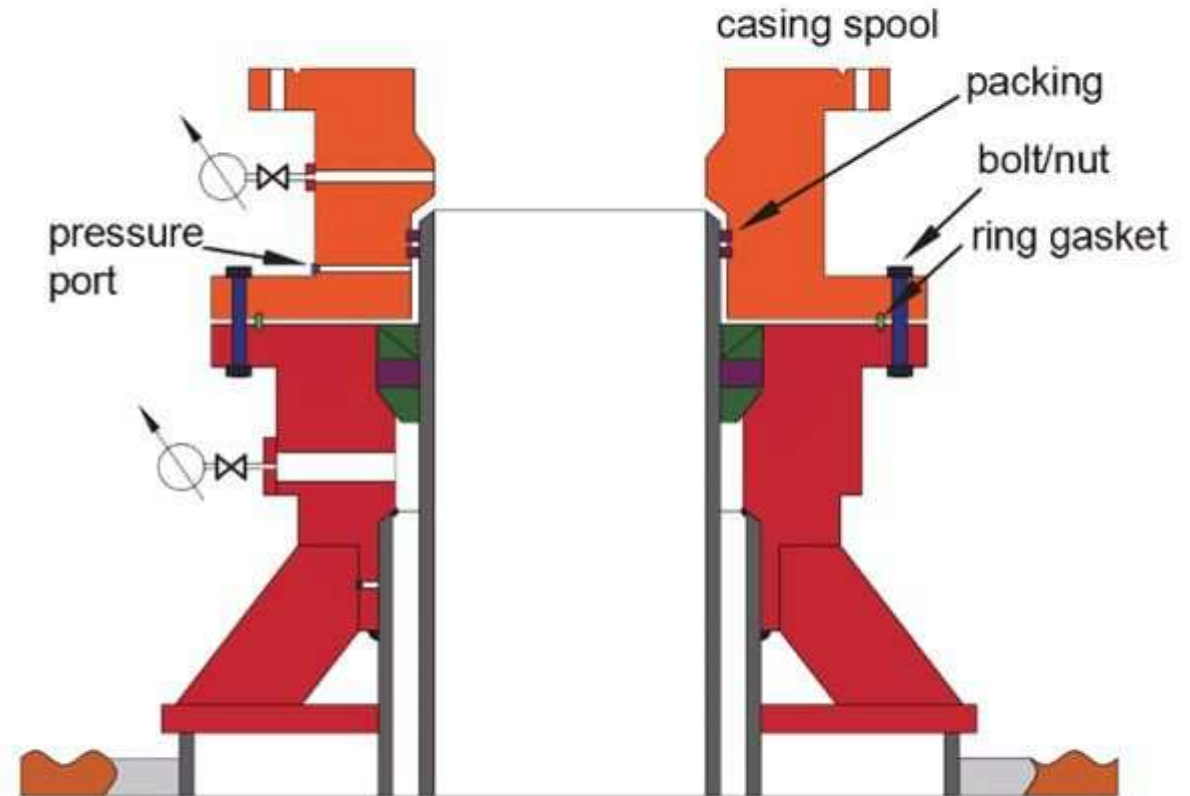
Wellhead Components

Wellhead assembly



C. casing head spool

- If a well includes one or more casing strings between the surface and production casing, the next component required after the casing head is the casing spool.



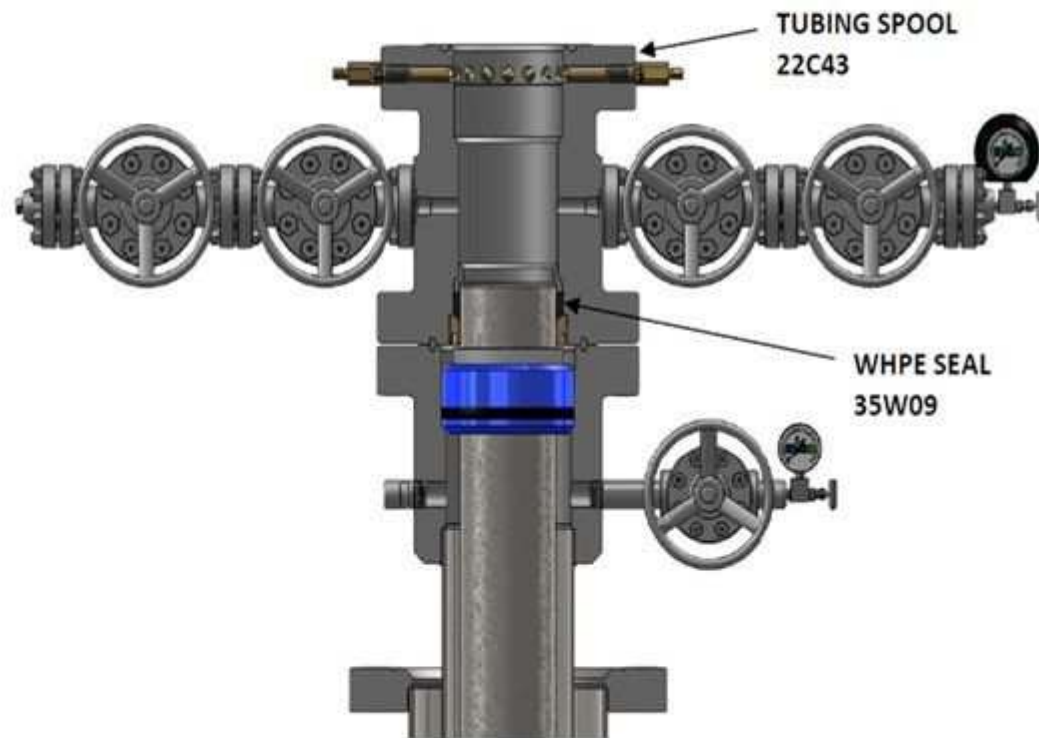


Wellhead Components

Wellhead assembly



C. casing head spool



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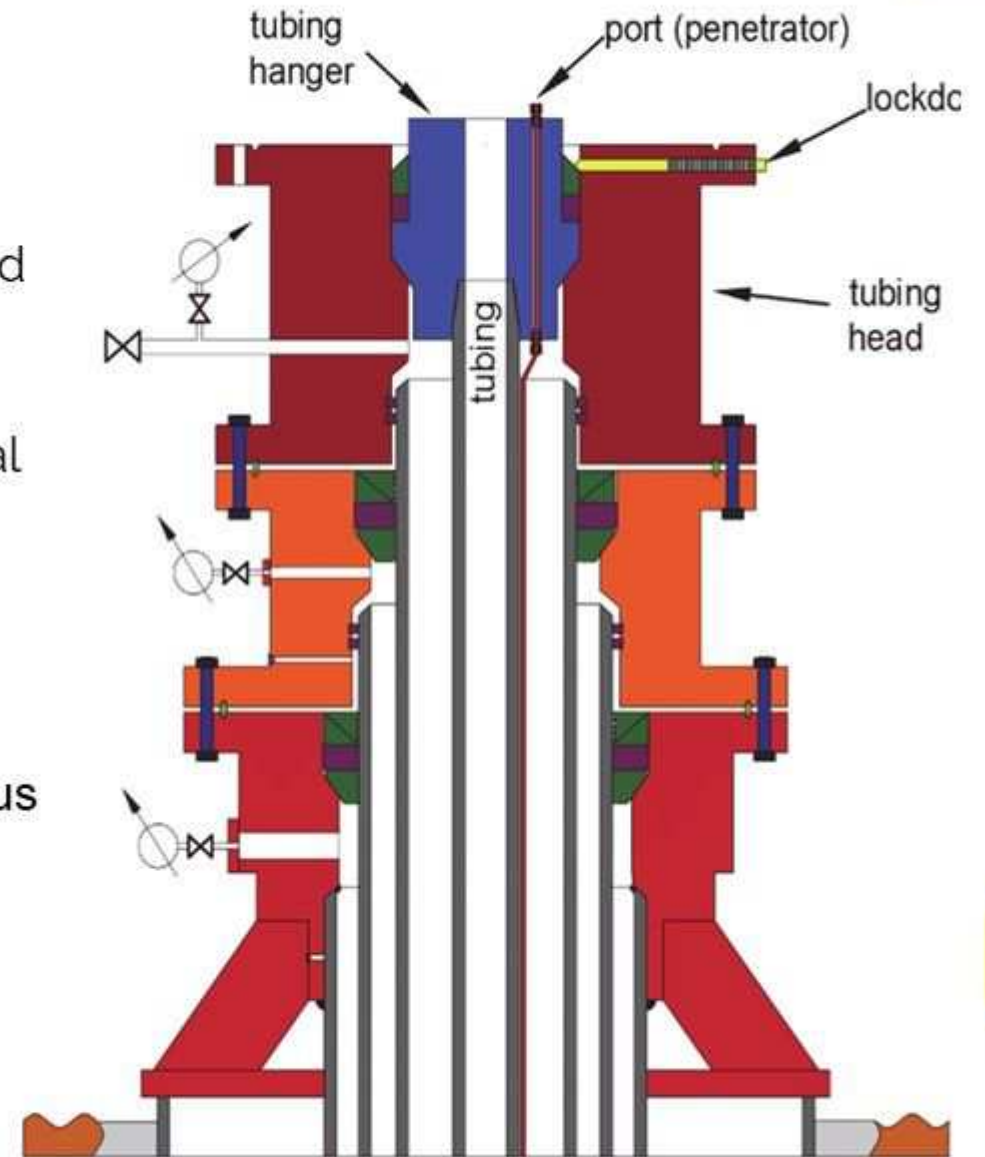
Wellhead Components

Wellhead assembly



D. Tubing Head

- Tubing Head is the uppermost spool in a wellhead assembly.
 - It provides a means to support and seal a tubing string
1. **Suspend** tubing with hanger
 2. Provide a hydraulic **seal** between tubing and annulus
 3. Provide access port(s) **to annulus**
 4. Provide **mounting for Xmas tree**





Wellhead Components

Wellhead assembly

E. Tubing Hanger

- Called Dog nut
- Tubing Head is the uppermost spool in a wellhead assembly.
- It provides a means to support and seal a tubing string
 1. **Suspend** tubing with hanger
 2. Provide a hydraulic **seal** between tubing and annulus
 3. Provide access port(s) **to annulus**
 4. Provide **mounting for Xmas tree**



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Tubing Hanger





Wellhead Components

Wellhead assembly



E. Tubing Hanger

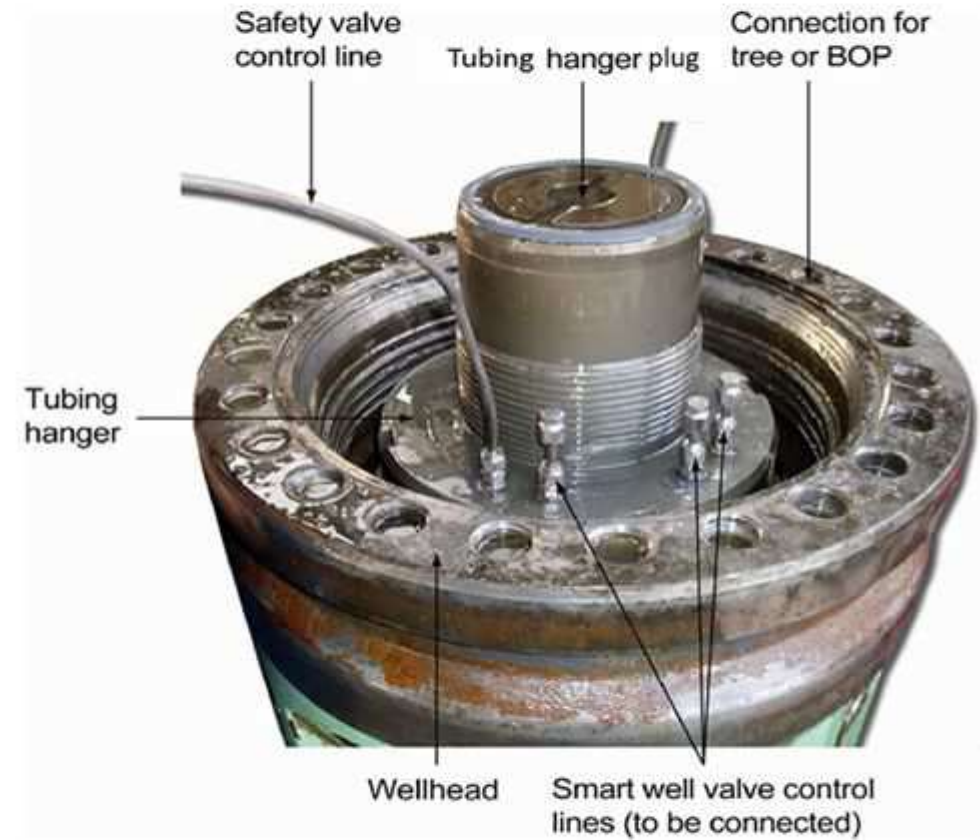
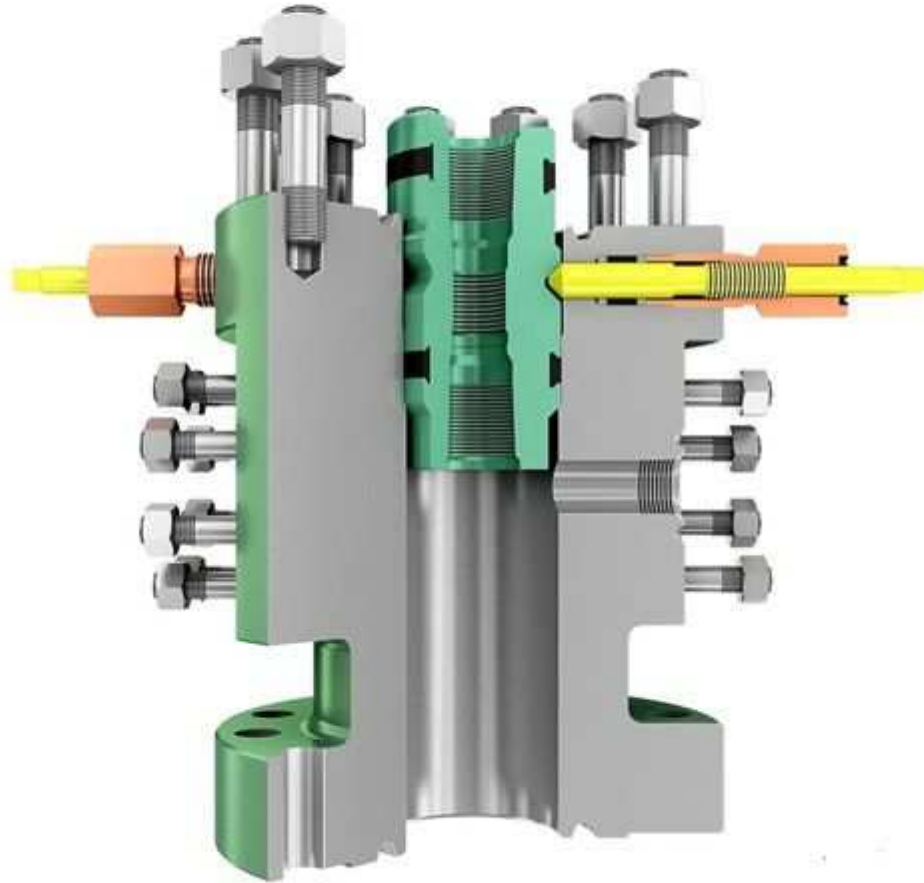


Figure 3.3 Tubing hanger—shown in situ in the wellhead before the tree is installed.





Wellhead Components

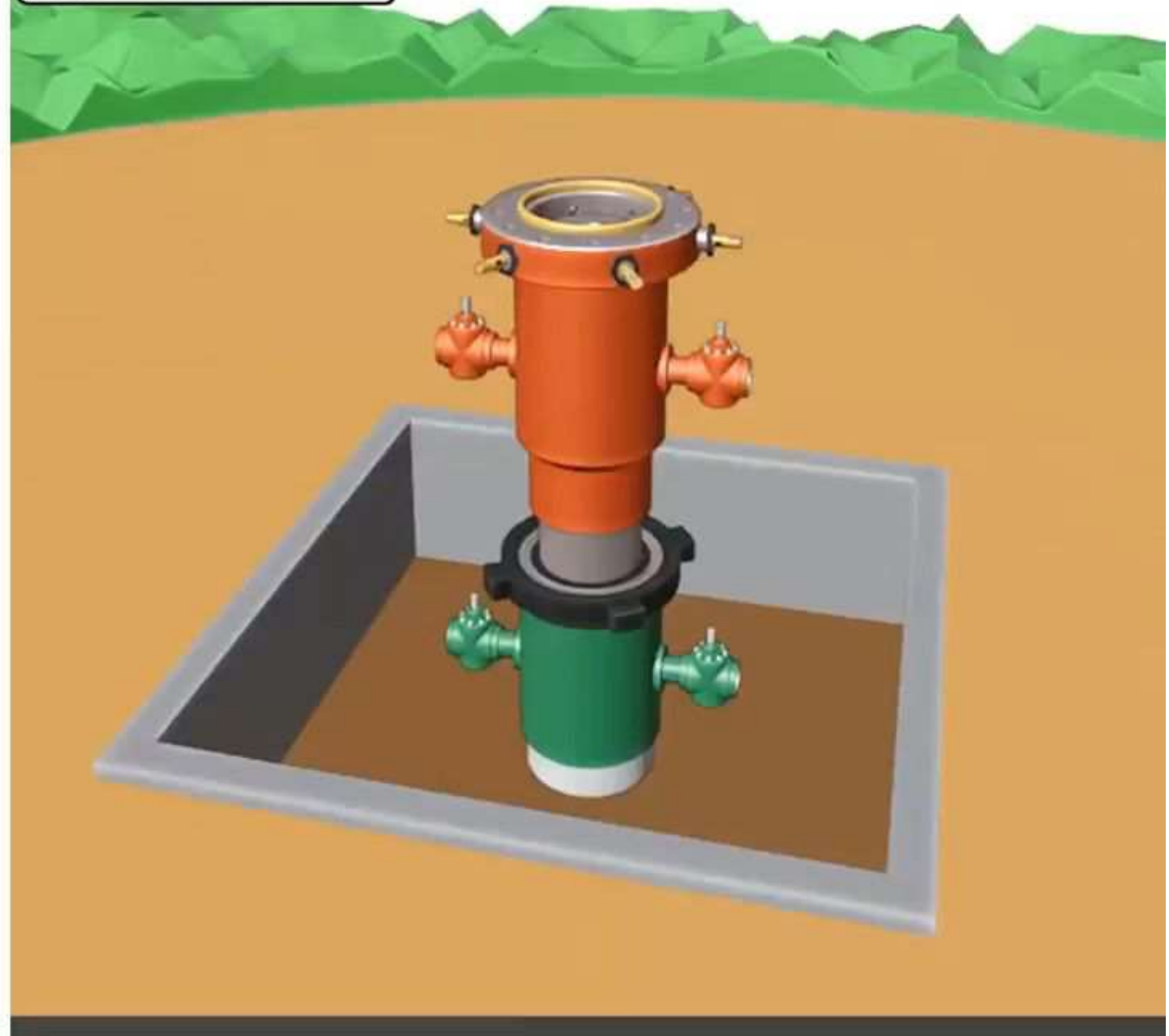
Wellhead assembly

E. Tubing Hanger



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Alison Silvas
@petroanimes





Tubing Hanger



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Tubing Hanger





Wellhead Components

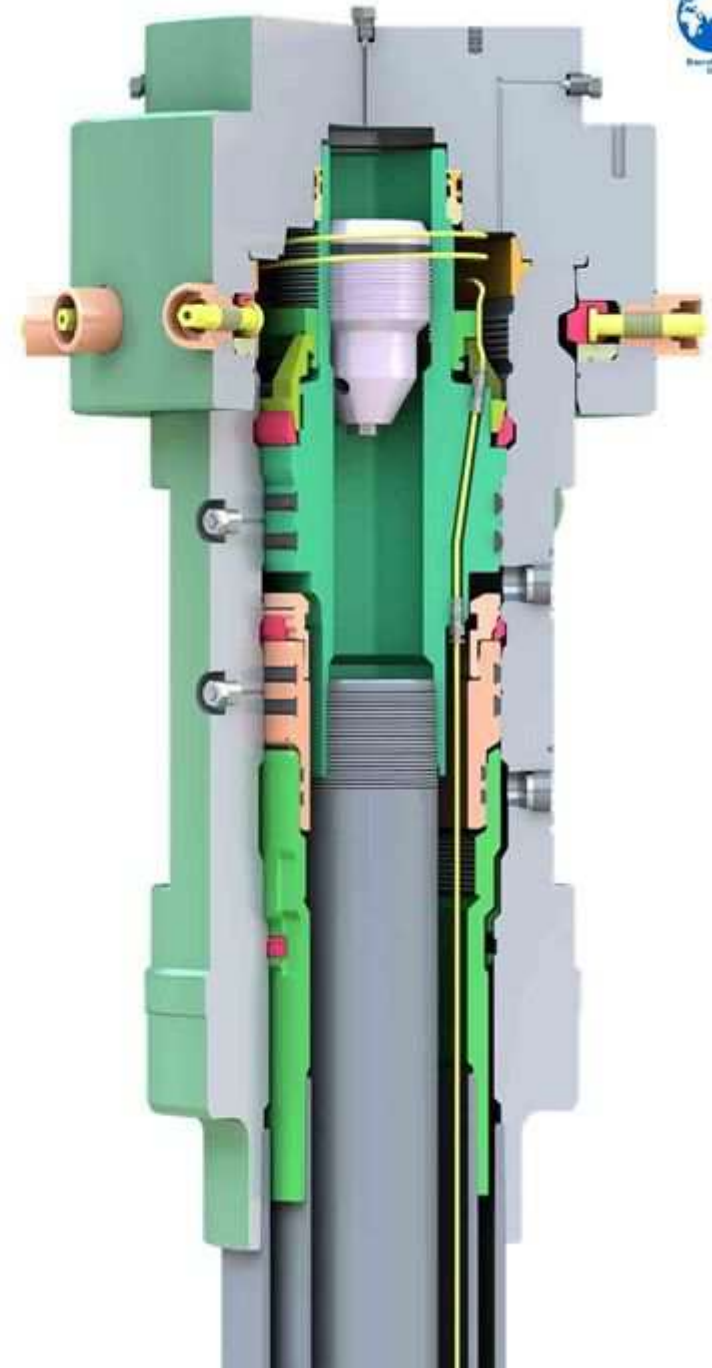
Wellhead assembly



F. Tubing Hanger Plug

Tubing hanger usually has a **place for locating:**

- 📦 Tubing Hanger Plug
- 📦 One way BPV
- 📦 Two Way BPV.





Wellhead Components

Wellhead assembly



BPV

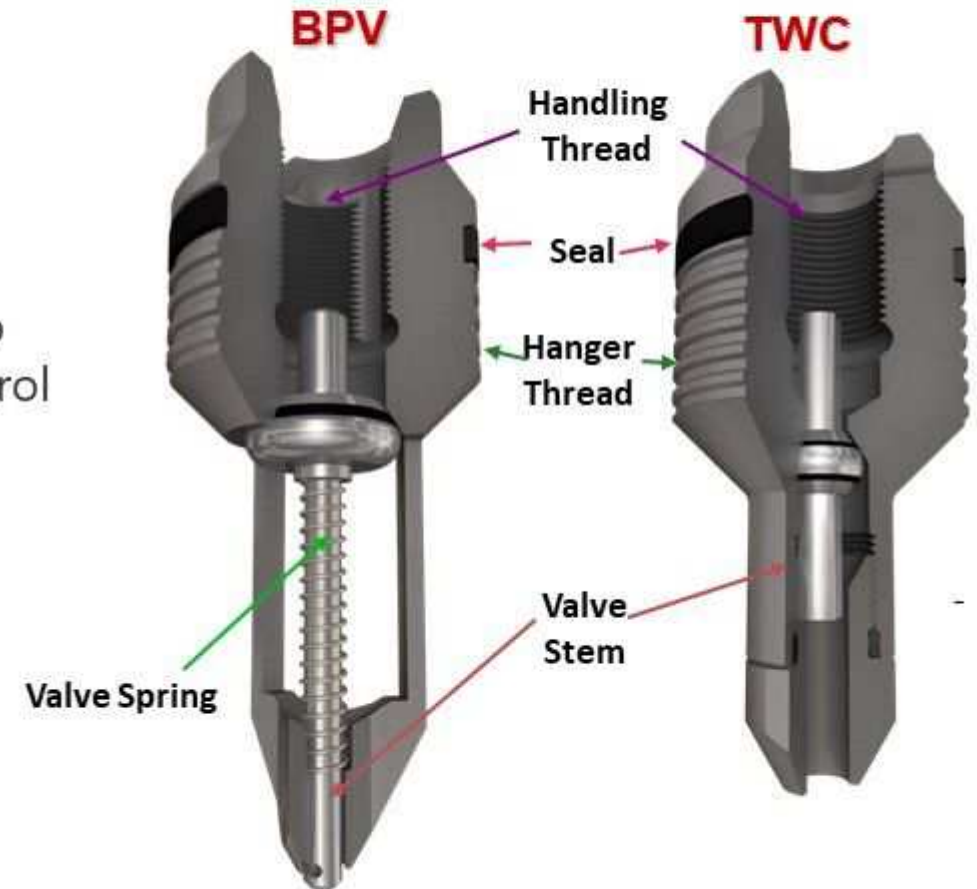
A type of check valve, typically installed in the tubing hanger, to isolate the production tubing.

One way BPV

designed to hold pressure from below yet enable fluids to be pumped from above, as may be required for well-control purposes.

Two way TWC

It holds pressure from both directions while allowing equalization when required and is used to test the tree and BOP assembly.



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Wellhead Components

Wellhead assembly



BPV

1. Nipple up or down BOP stack.
2. Nipple up or down Christmas tree.
3. Test the Christmas tree (2-way check).
4. Replace the master valve.



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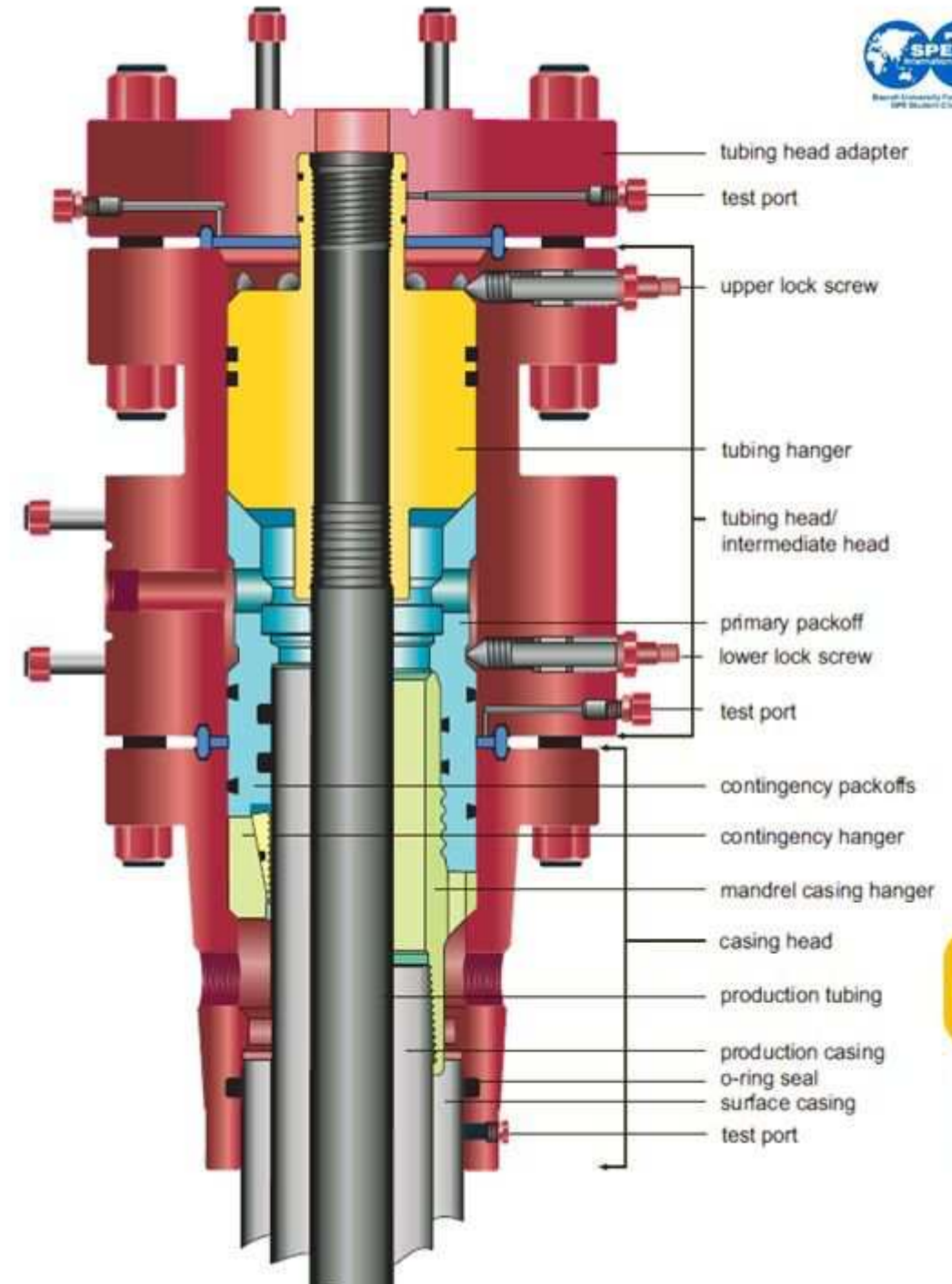
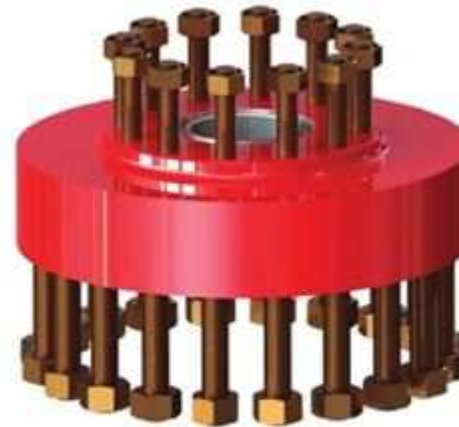
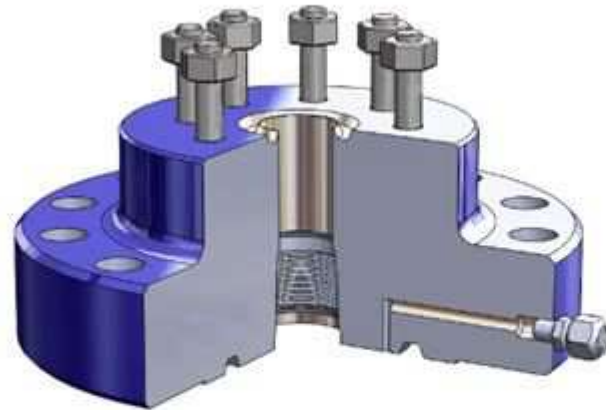
Wellhead Components

Wellhead assembly



G. Tubing Head Adapter

- The tubing head adaptor provides a transition from the tubing head to the Christmas tree.





Wellhead Components

Wellhead assembly

G. Tubing Head Adapter



2-9/16"
10000 PSI WP
BX-153 RING

7-1/16"
15000 PSI WP
BX-156 RING



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Wellhead Components

Basic Components



Wellhead Terminology



Tubing head



Casing spool



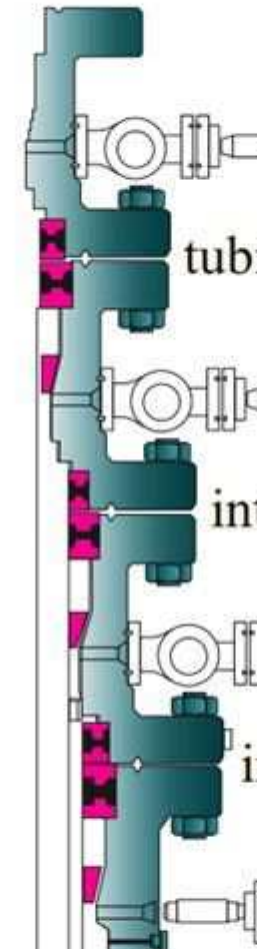
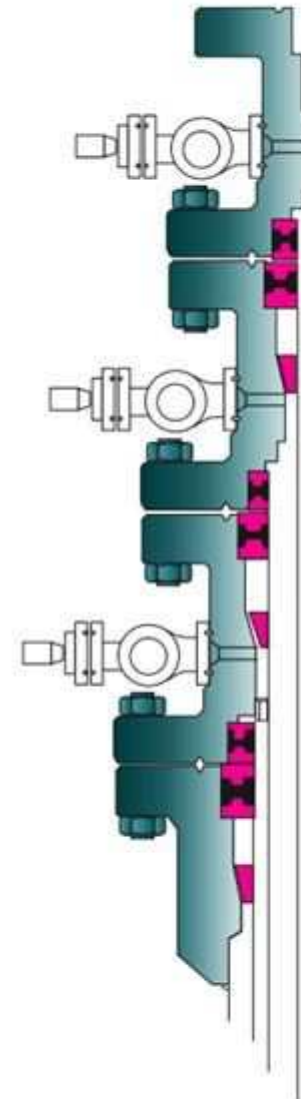
Casing hanger



Casing head



Base Plate



tubing spool

intermediate spool

intermediate spool

20"

13 3/8"

9 5/8"

7"

base flange



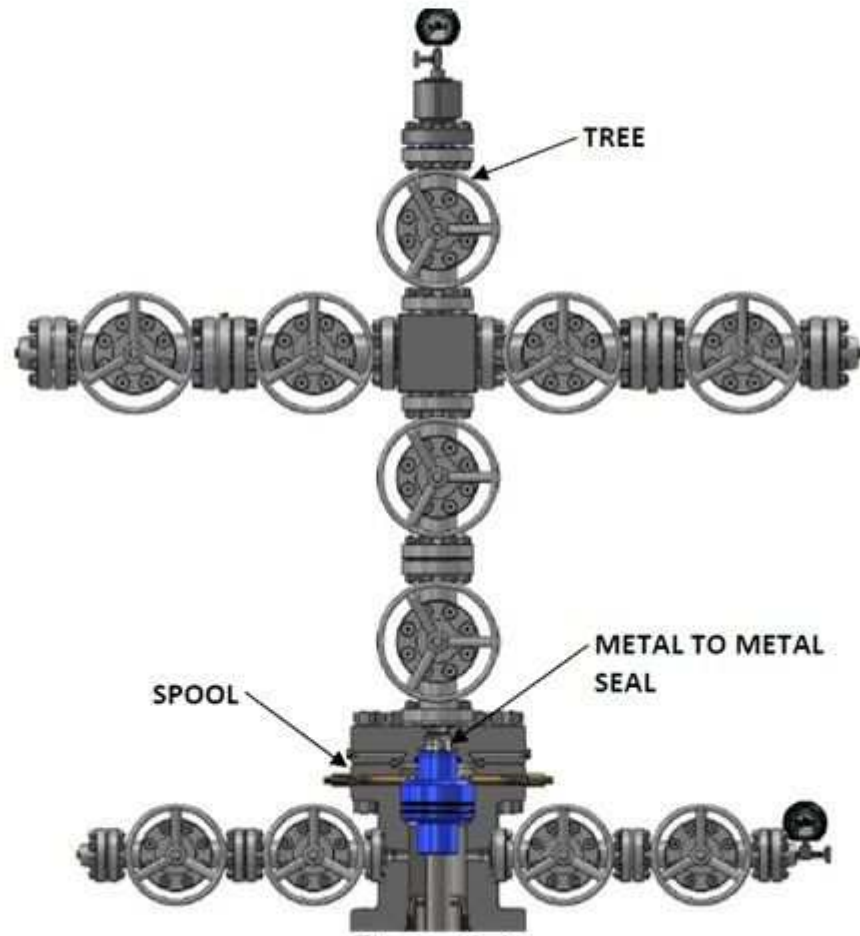
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Wellhead Components

Basic Components

Nipple Up of Christmas tree



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clideo.com

05

X-mass tree Assembly

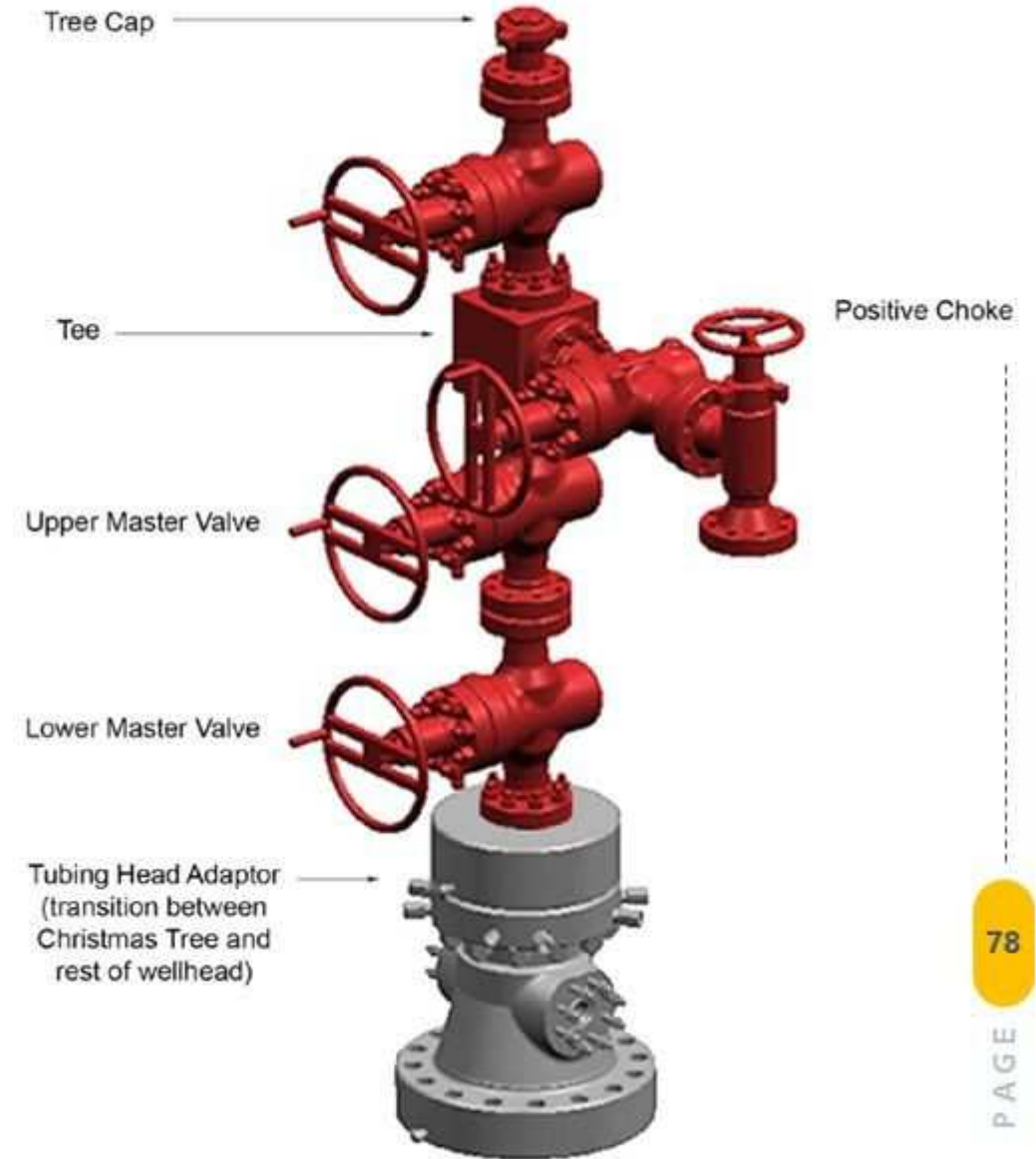




X-mass tree

X-mass tree assembly

- Xmas Tree is an assembly of valves, all with specific functions,
- Used to control flow from the well
- Also to provide well intervention access for well maintenance or reservoir monitoring.





X-mass tree

X-mass tree assembly

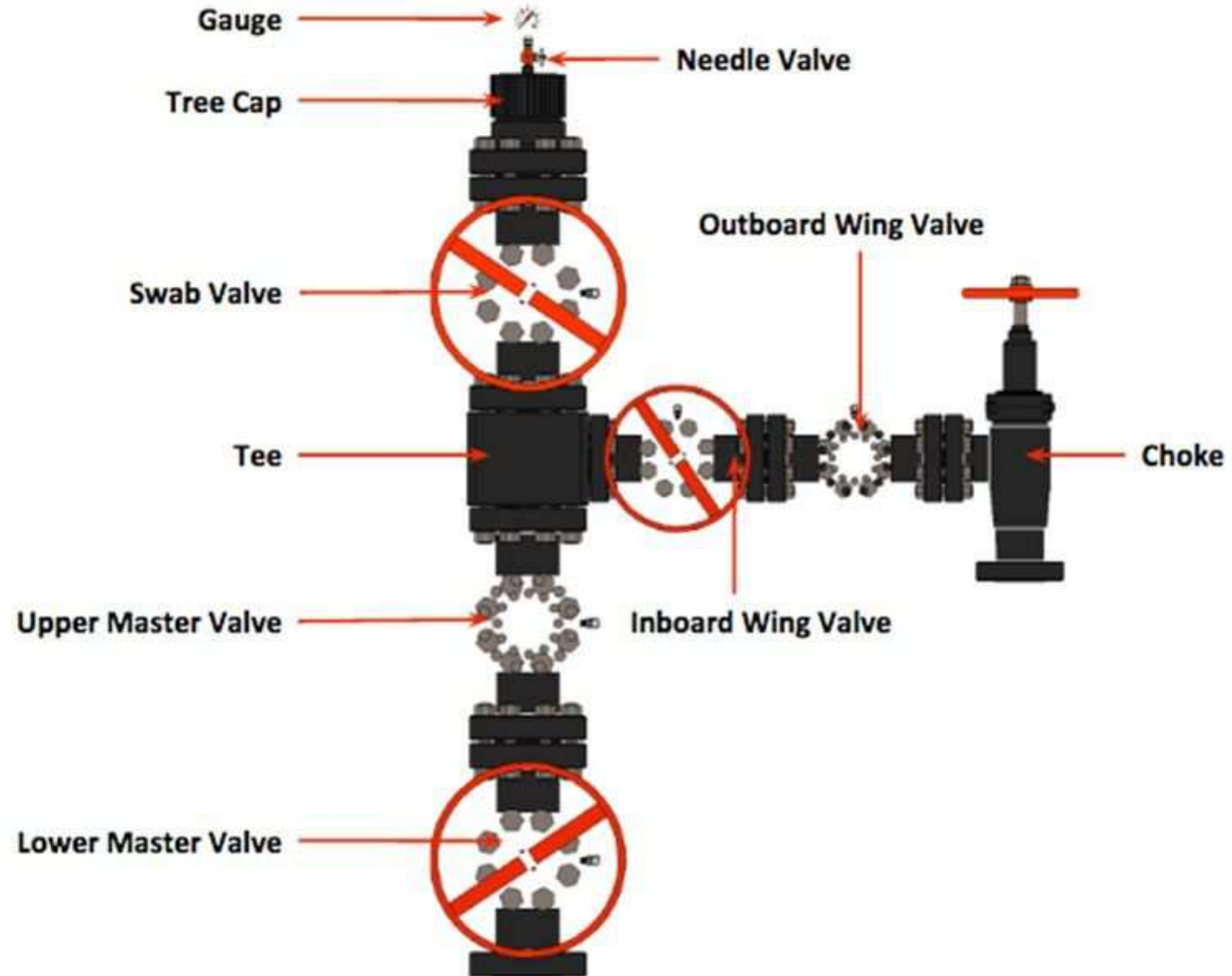
- The Christmas tree is pressure control system located at the well head.





X-mass tree

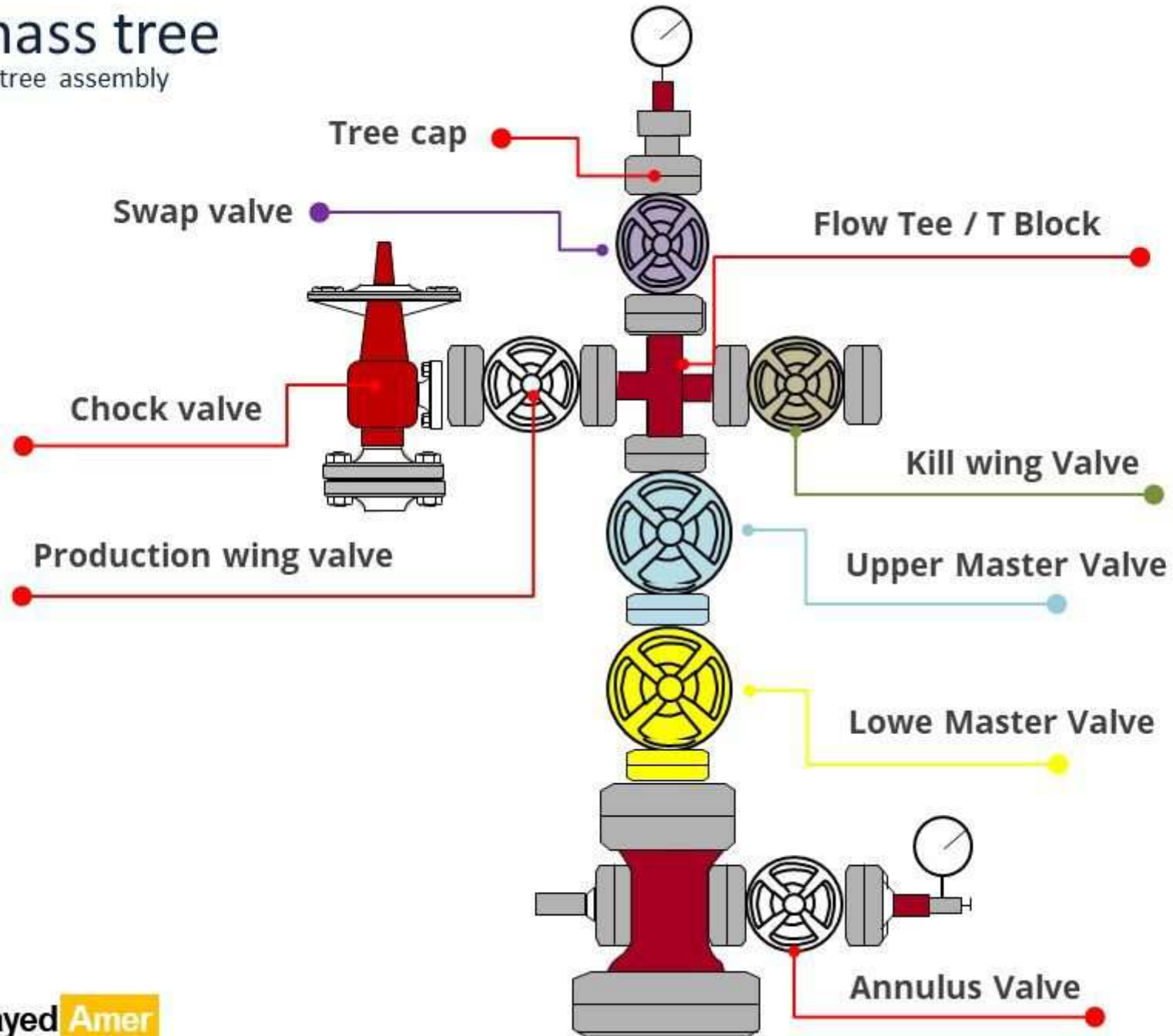
X-mass tree assembly





X-mass tree

X-mass tree assembly

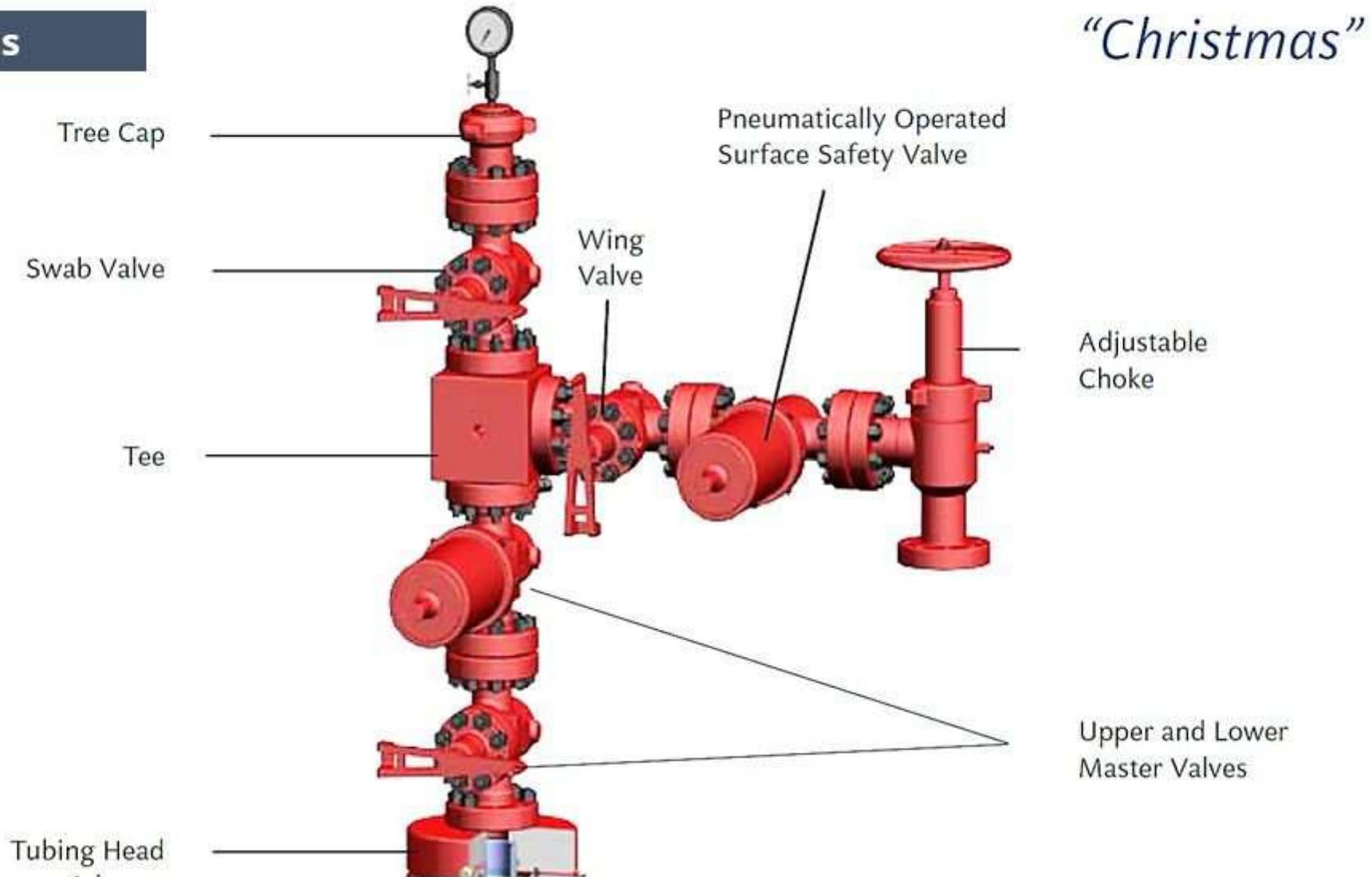




X-mass tree

X-mass tree assembly

Functions



“Christmas”



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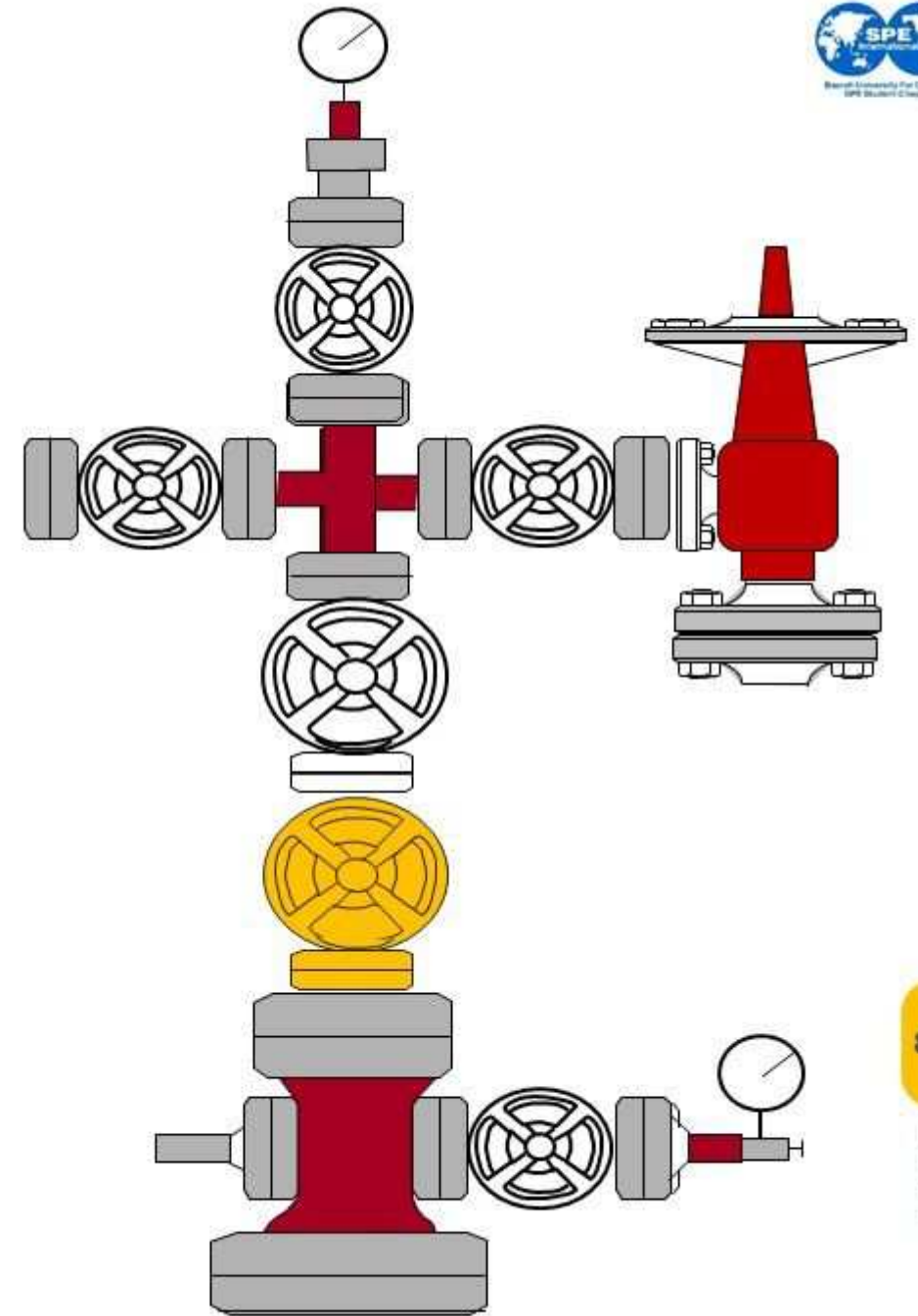


X-mass tree valves

X-mass tree assembly

1. Lower Master Valve

- **Manually** operated **gate** valve.
- Used as **last resort** to shut in the well.
- Used as (back-up valve).
- **Locked open** during operation.
- Require **well intervention** to be **replaced** if passing.
- **Two valves** are often used because they provide redundancy. If one master valve cannot function properly, another valve can perform the function



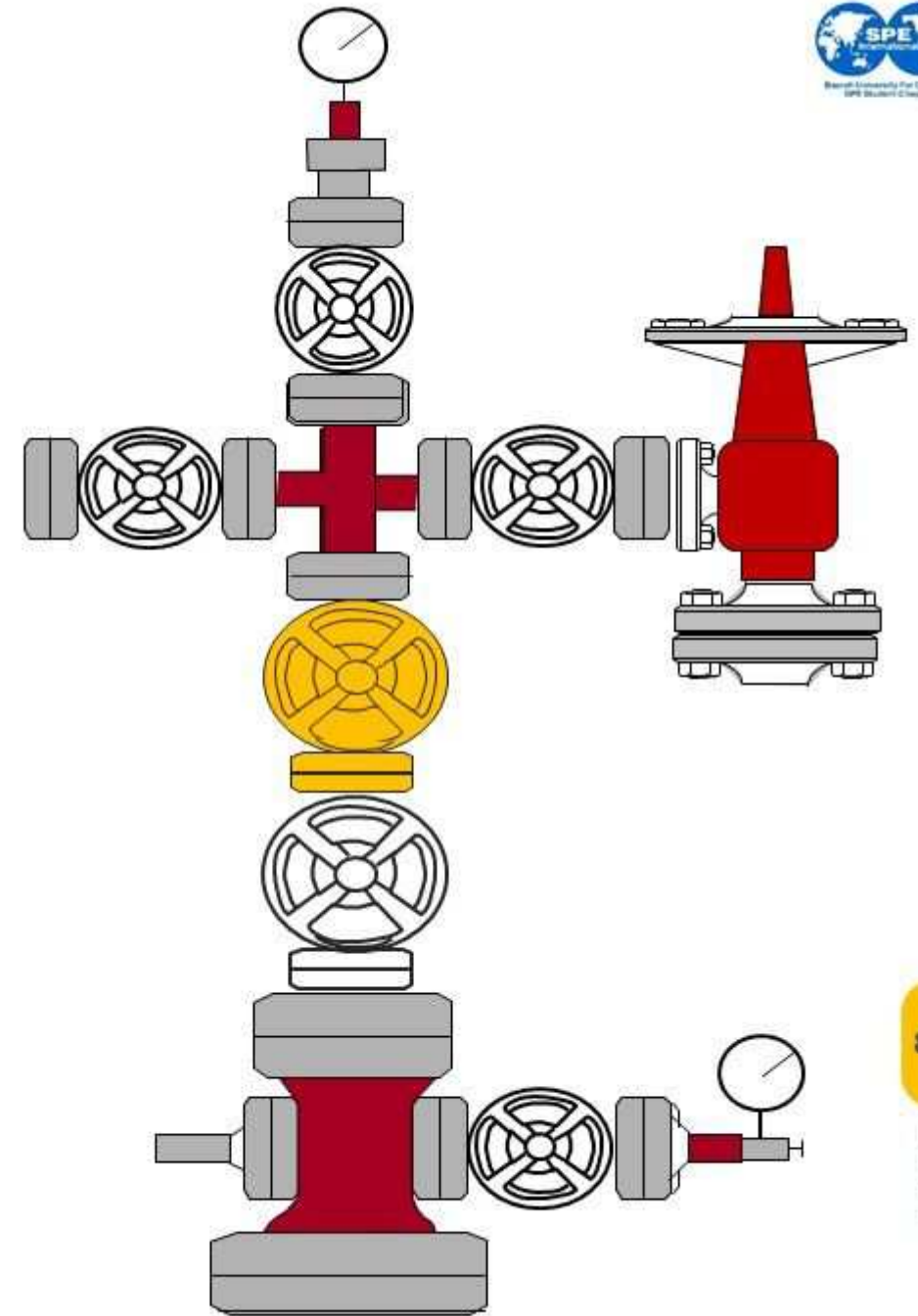


X-mass tree valves

X-mass tree assembly

2. Upper Master Valve

- **Manually** or **actuated gate** valve.
- usually operated to **open** and **close** the wellbore.
- This valve is often fitted with an actuator so that the valve can be controlled remotely.





X-mass tree valves

X-mass tree assembly



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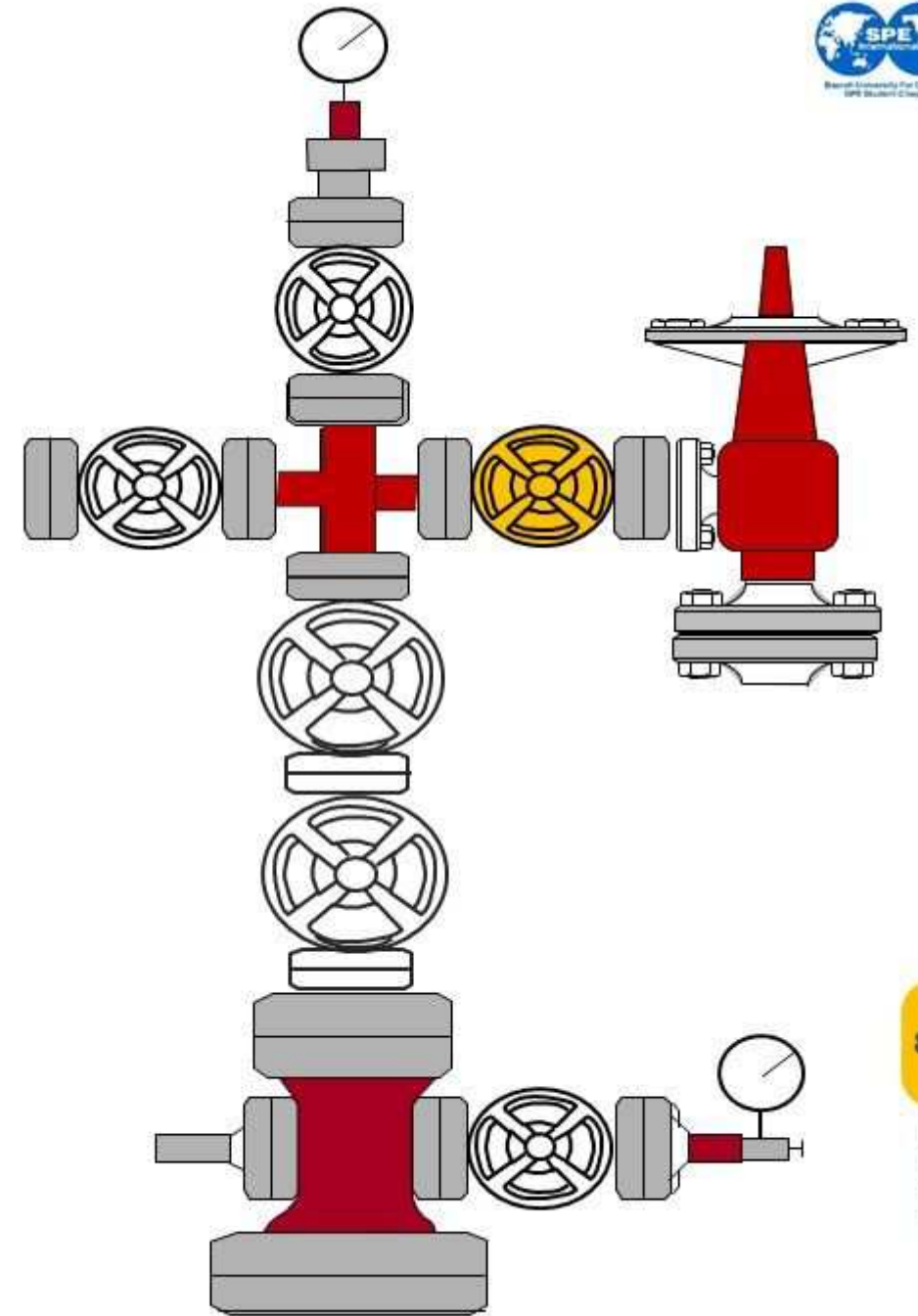
X-mass tree valves

X-mass tree assembly



4. Production Wing Valve

- located on the side of a Christmas tree
- Used to **control** or **isolate production** from the well into **surface pipeline**.
- Depending on each design of a Christmas tree, it can be equipped with one or two wing valves.





X-mass tree valves

X-mass tree assembly



4. Production Wing Valve



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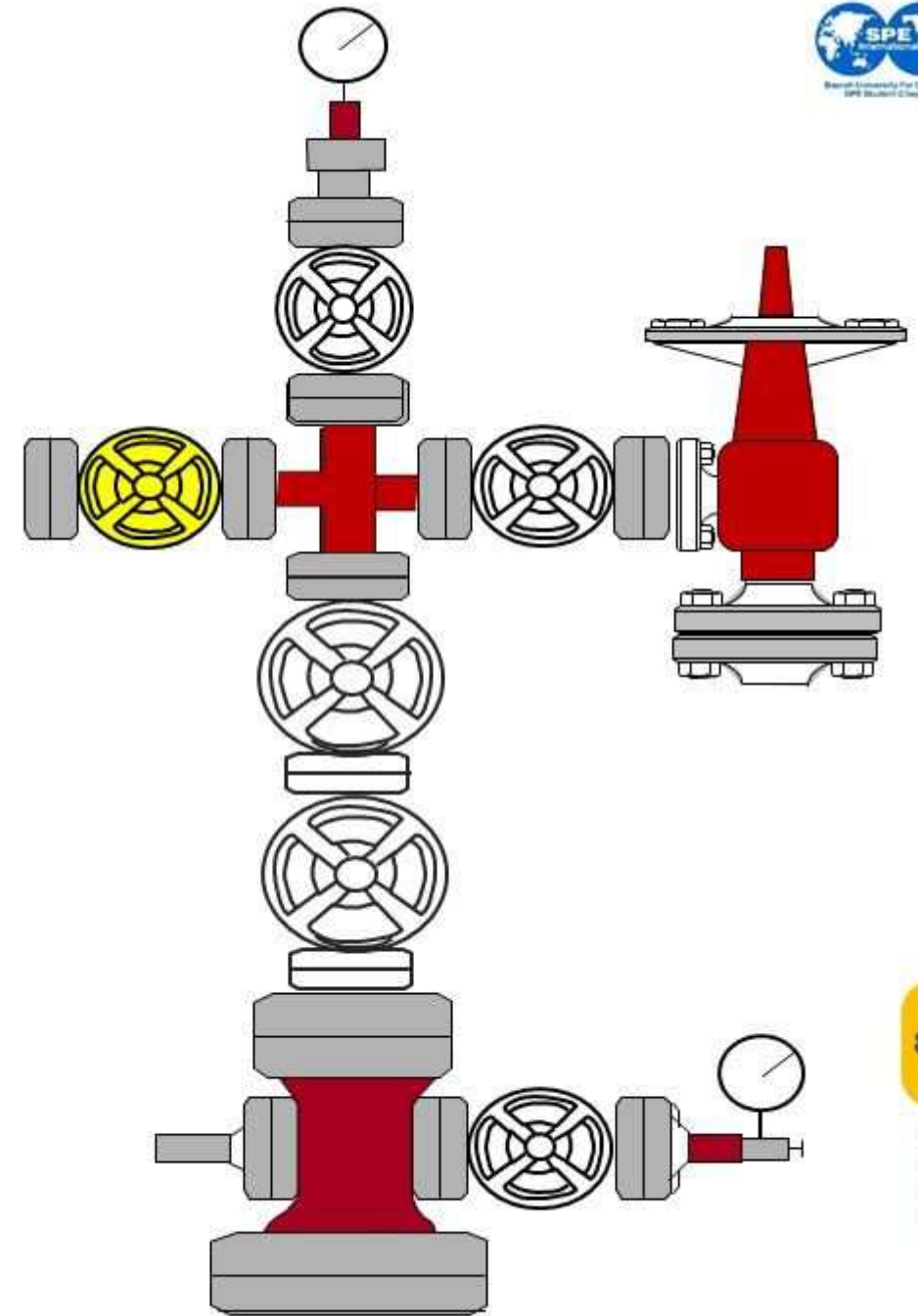
X-mass tree valves

X-mass tree assembly



5. Kill Wing Valve

- located on the side of a Christmas tree
- Enables **connection** of **pumping** equipment to pump **kill** fluid into the well for well **intervention**



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X-mass tree valves

X-mass tree assembly

5. Kill Wing Valve



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X-mass tree valves

X-mass tree assembly

5. Kill Wing Valve



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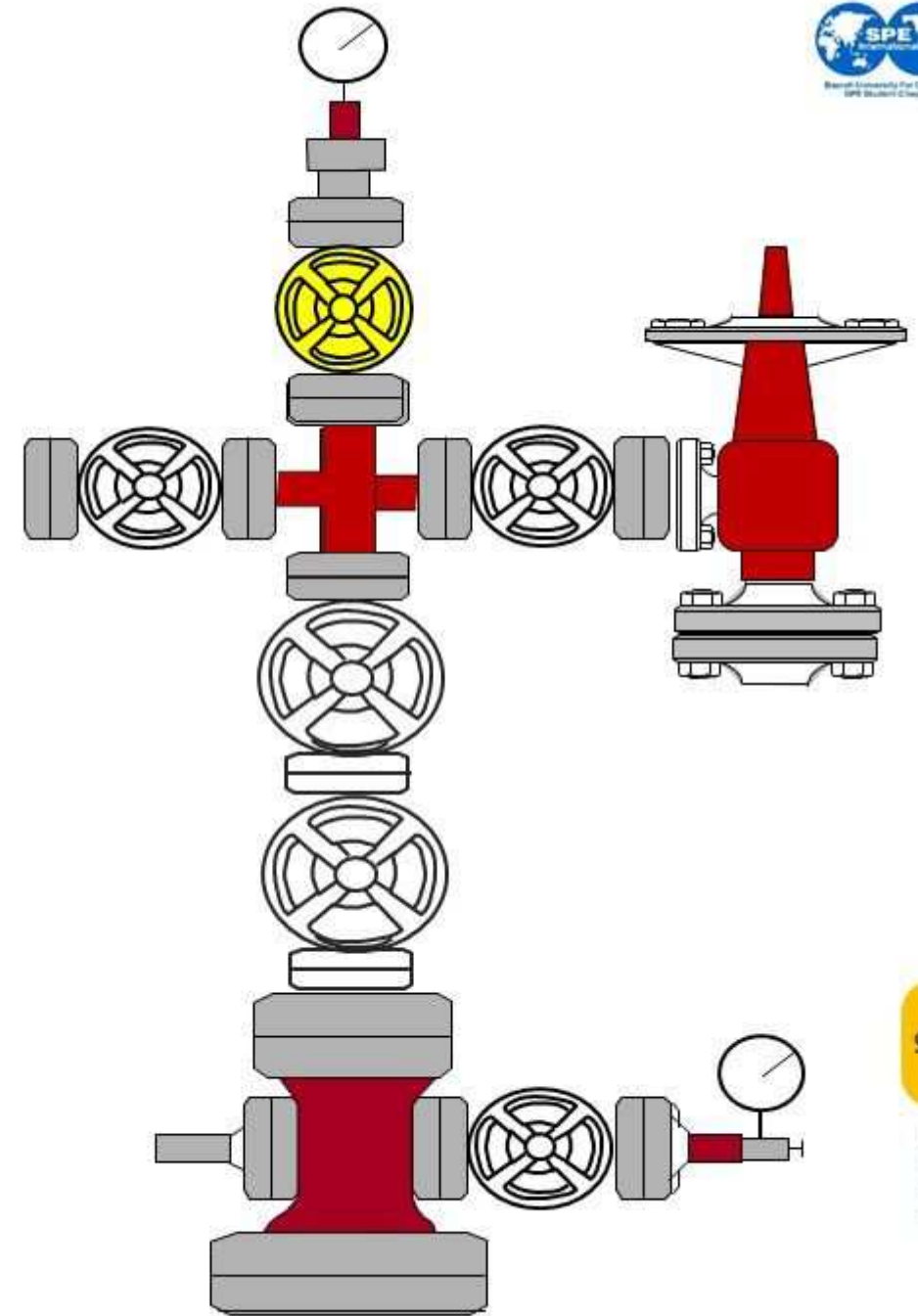
X-mass tree valves

X-mass tree assembly



6. Swab Valve

- Topmost valve
- Provide a vertical **access** to the well for **well intervention** operations conducted by **wireline**, **slickline**, **coiled tubing** or a snubbing unit.





X-mass tree valves

X-mass tree assembly

6. Swab Valve



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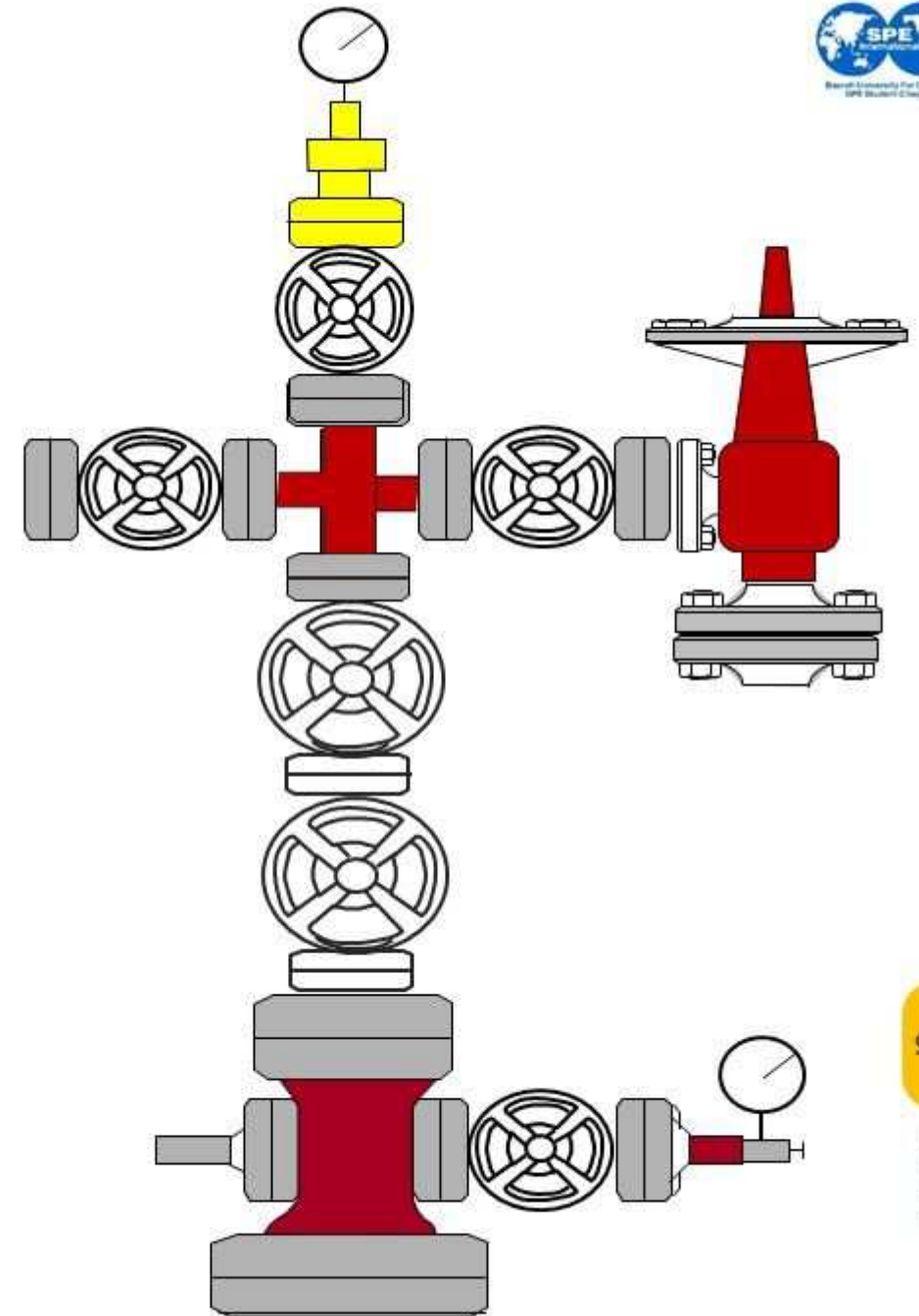


X-mass tree valves

X-mass tree assembly

7. Tree cap Valve

- T-Cap is a flange located on **top of** the **swab valve** which **allows** a **wireline** lubricator or a **coiled** tubing/ **snubbing** unit **BOP** to be **connected** to a well in order to perform well **intervention** programs.









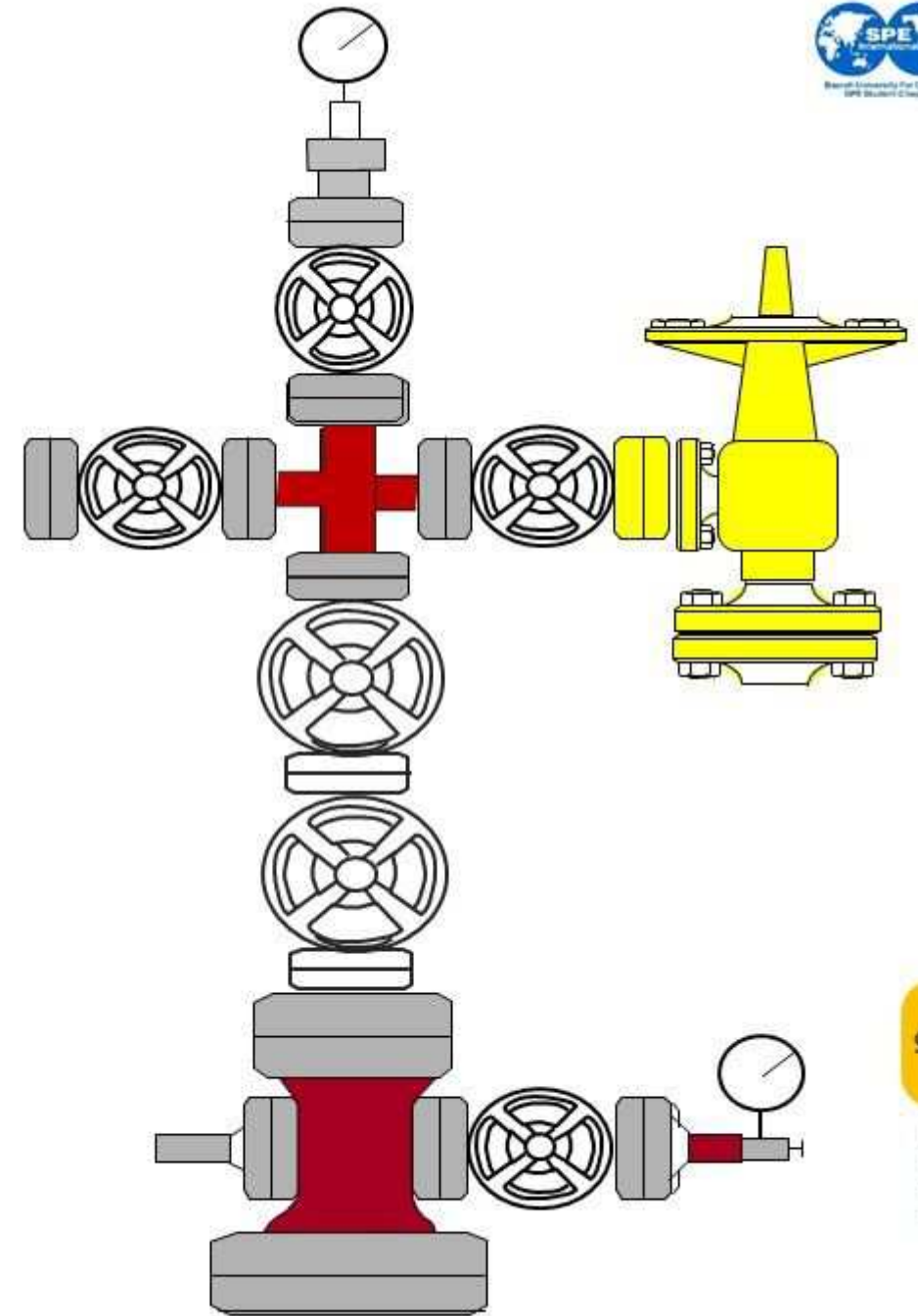
X-mass tree valves

X-mass tree assembly



7. Choke Valve

- Used for Adjust the **production rate** up to pressure of 20,000 psi.
- To reduce the FLOWING pressure.
- Control sand and water production





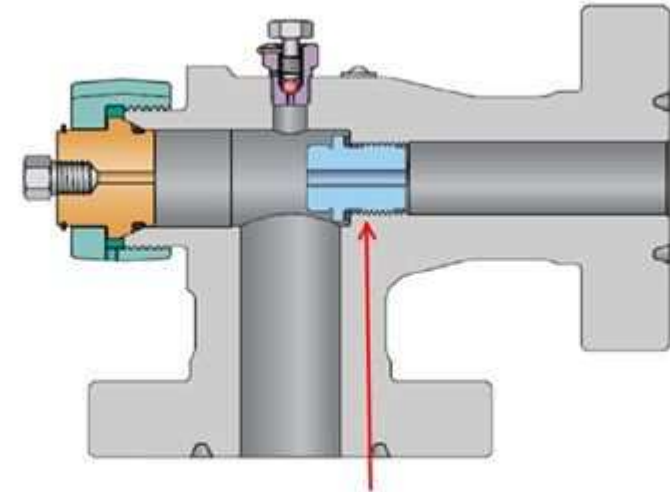
X-mass tree valves

X-mass tree assembly

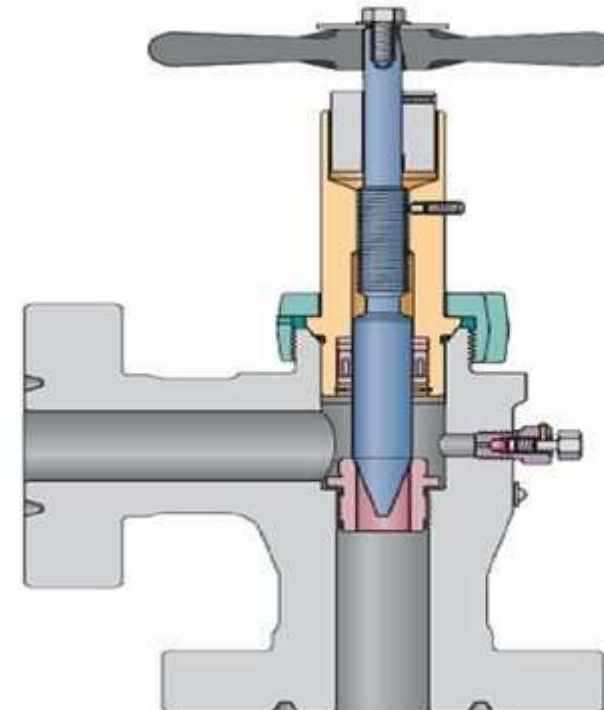
7. Choke Valve

Most Common Chokes

1. **Fixed:** (Positive chokes are used in applications where the well flows at a very constant rate)
 - Fixed orifice
 - Disassemble to change bean
2. **Adjustable:** The adjustable choke valve is designed to adjust the effective area available, for the flow to control the production rate, through rotating the hand wheel



Fixed orifice or bean





X-mass tree valves

X-mass tree assembly

7. Choke Valve



Fixed or Positive



Adjustable Chokes





X-mass tree valves

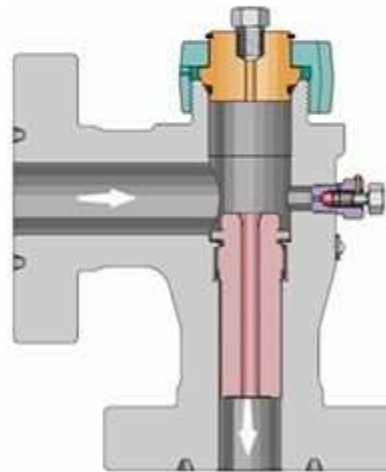
X-mass tree assembly



Choke Throttling Methods

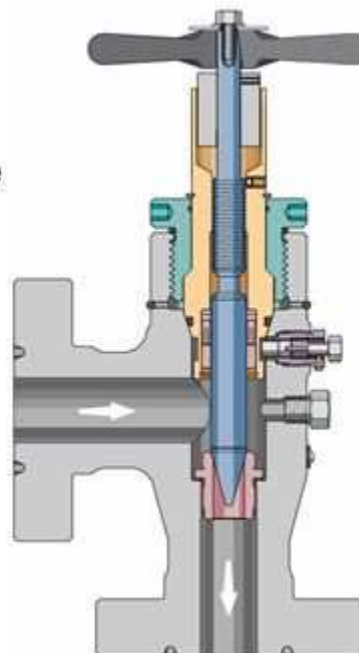
Fixed Bean:

- Best for infrequent adjustments
- Used on Production Xmas trees



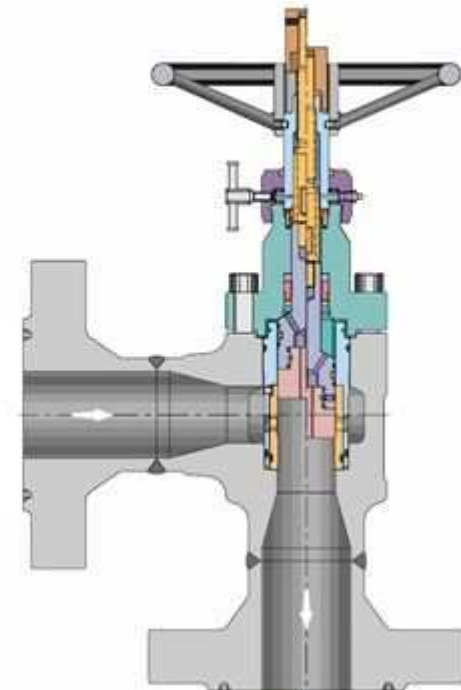
Needle and Seat:

- Simplest application
- Least expensive adjustable choke
- Best for pressure control
- High capacity



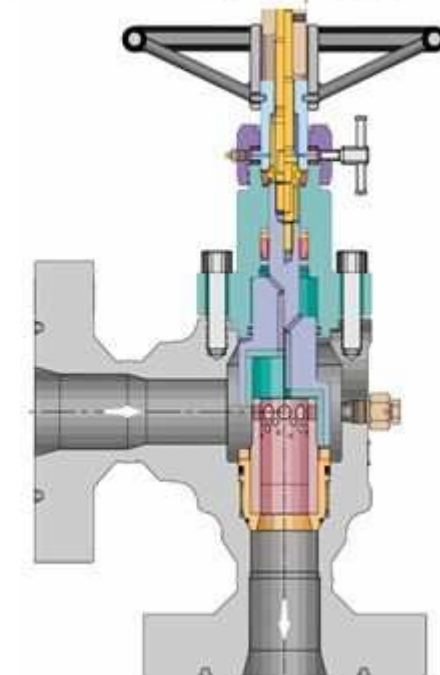
Plug and Cage:

- High capacity
- Good controllability
- Eliminates body erosion



External Sleeve:

- Superior erosion resistance
- Eliminates body erosion



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X-mass tree valves

X-mass tree assembly

8. GATE Valve

1. A special mechanical valve used in oilfields to **control (close-open)** flow stream.
2. Used in Christmas tree, wellhead assembly, frac trees, choke manifold, kill manifold, debris catcher, sand filter, cyclone wellhead desander, line heater, etc.
3. **3K, 5K, 10K, 15K, 20K**

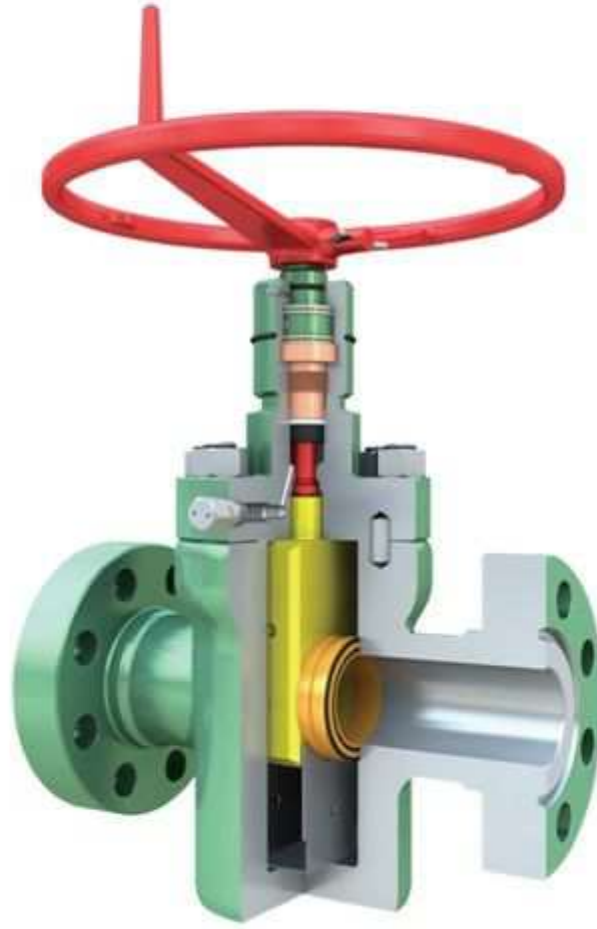




X-mass tree valves

X-mass tree assembly

8. GATE Valve



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X-mass tree valves

X-mass tree assembly

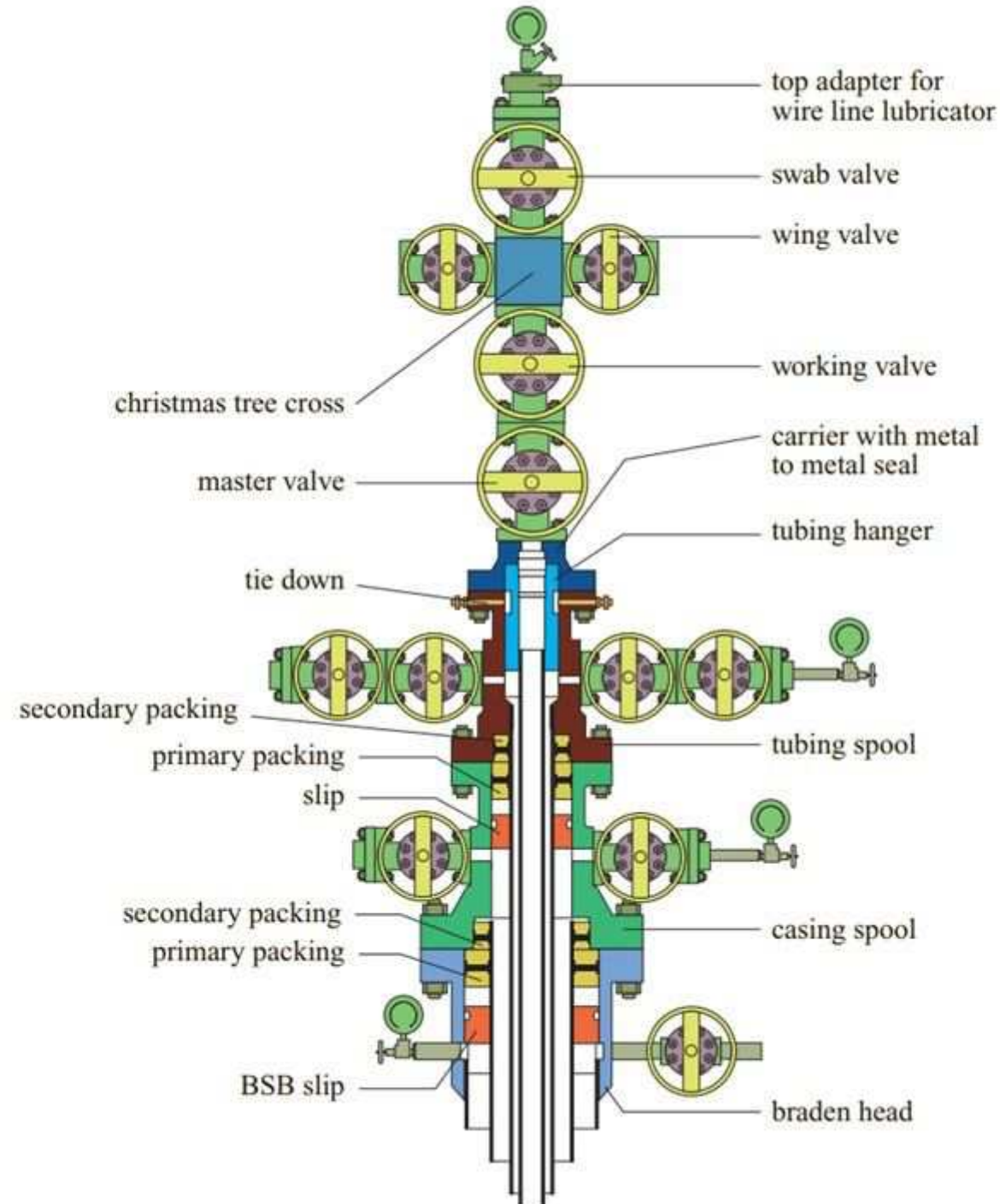


8. GATE Valve

API 6A Gate Valves



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completion section

drilling section

