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Supply of Subsea Christmas Trees and Wellheads

GP 78-23

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Introduction

This is the first draft of Group Instruction for Supply for Subsea Christmas Trees and Wellheads GP 78-23. This practice is intended to provide guidelines for the design and selection of Subsea Christmas Tree and Wellhead equipment, particularly for deepwater applications. API Specification 17D for Subsea Wellhead and Christmas Tree Equipment and ISO 13628-4 Subsea Wellhead and Tree Equipment have been used as the basis of this document. This document is meant to supplement certain requirements of these industry specifications.

The document sequence and layout is the same as that of ISO 13628-4. Section and sub section headings are repeated in this document. Additional information or comment is added where appropriate.

It should be noted that local governmental regulations for offshore operations take precedence over any guidelines.

Two specific additions to the standards related to wellheads are an Addendum containing company recommended design procedures and an Addendum outlining requirements that provide data needed by the completions and development groups that access the well at a later date.

The document is based in part on the following BP documents:

- Gulf of Mexico Deepwater SPU Standard Subsea Tree System Functional Specification – STP 78-23-01.
- Gulf of Mexico Deepwater SPU Standard Subsea Wellhead System Functional Specification – STP 78-23-02.
- Universal Wellhead Specification.
- BP Egypt Wellhead Specification.
- GOM Wellhead Abandonment Specification.
- DWD Wellhead Design & Operations Integrity Assurance Checklist.



1.0 Scope

1.1 Add:

The purpose of this document is to present certain enhancements to the requirements of API 17D and ISO 13628-4 for subsea trees and wellheads. The document does not deviate from the stated purpose to produce safe, dimensionally and functionally interchangeable subsea equipment. It is meant to supplement not supersede API Specification 17D/ISO 13628-4.

1.2 **Equipment**

Add:

This Group Instruction for Supply is written to address equipment and tooling for the wellhead system, tubing head spool assembly, tubing hanger systems, subsea tree assembly, and tree cap. The focus is on deepwater systems which will require equipment that can be installed without guidelines.

Industry practice has moved more toward these GLL operations particularly for interventions such as choke insert change out, control pod installation/removal, and installation/removal of flowline jumpers. These operations are typically conducted from a dynamically positioned intervention vessel that does not use guideline orientation/landing equipment.

Running tools are excluded from the scope of 17D. This document is written with the intent that tooling for the tree and wellhead systems are to meet the intent of ISO 13628-4/API 17D. Specific requirements for tools are provided by this document in addition to those given in Appendix "G" of API 17D.



2.0 Normative References

Add:

API Specification 6A Wellhead and Tree Equipment.

API Specification 17D Specification for Subsea Wellhead and Christmas Tree Equipment.

ETP GP 36-20 Specification and Selection of Materials for Subsea Equipment.

Always be aware that there will be requirements dictated by regional government regulation that must be followed. These regulations, of course, take precedence over any other requirements.

For example, MMS regulations for USV certification states that manufacturers need to have a quality program based on API 1Q in place. Also, USVs need to meet API 6A and 6 AVI requirements for design and testing.



3.0 Terms, Definitions, Symbols, and Abbreviations

3.1 Terms and Definitions

Add:

Terms	
Work Class ROV	ROV system that can deliver at least 100 BHP subsea
Flow Base	Structure and piping usually attached to the wellhead to allow tree connection to subsea architecture
Tubing Head Spool	Allows suspension of tubing and provides structure for a flow base
Under Water Safety Valve	Valve that has been tested and certified per MMS requirements. Normally, the production master and production wing valves bear this designation.
Casing hanger	Supporting assembly for casing strings landed in the wellhead body
Casing hanger pack-off	Sealing assembly for casing hangers landed in the wellhead or other body
Debris cap	Cover for the wellhead or tree used to prevent mechanical damage, corrosion, and the ingress of debris after the suspension of the well
Connector profile	Mating face which provides a sealing surface and enables a mechanical connector to be locked in place
Metal to metal	Verifiable, 100% metal seal contact with a metal sealing surface
Flow-by area	Unrestricted area through which fluids can by-pass
Particle size	The maximum size of particle which can pass the flow-by
Positive surface indication	Unambiguous sign at the rig floor that a particular operation has been successfully completed. Overpull is an acceptable technique
Sour environment	Condition created by the presence of hydrogen sulfide in the downhole environment
Corrosive environment	Condition relating to the corrosivity of the retained fluids based on the partial pressure of carbon dioxide and other factors.

3.2 Symbols and Abbreviations

Add:

Acronyms	
BHA	Bottom Hole Assembly
ISO	International Standards Organization
QA	Quality Assurance
SWL	Safe Working Load
MMS	Minerals Management Service
CFR	Code of Federal Regulations
ROV	Remote Operated Vehicle
FLOT	Flying Lead Orientation Tool
USV	Under Water Safety Valve
GLL	Guide Line Less
THS	Tubing Head Spool
PR-2	Performance Requirement Level 2
SOR	Statement of Requirements – project specific document
USV	Underwater Safety Valve
DP	Dynamically Positioned



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Acronyms	
PQR	Procedure Qualification Record
SIT	System Integration Test
WPS	Welding Procedure Specification
VIV	Vortex Induced vibration
BOP	Blow Out Preventer
MSV	Multipurpose support Vessel



5.0 Common System Requirements

5.1 Design and Performance Requirements

5.1.1 General

Add:

The subsea tree and wellhead systems covered by this document will be designed for up to 10,000 foot water depths and will be deployed in Guidelineless (GLL) mode with a funnel down guidance/alignment system. The tree should be designed such that it can be deployed on drill pipe, completion riser, or motion compensated wire system.

The subsea tree will be a diverless design and as such will require that many ROV activities should be anticipated in the tree design. The tree design should provide adequate access for a work class ROV to perform its tasks and include the necessary intervention fixtures and tooling. Position indicators should be positioned for viewing by an ROV camera. Marking visibility should be considered in the layout of the tree assembly.

All valves, chokes, actuators, check valves, connectors, hangers, seals, proprietary connections, etc. shall be qualified in accordance with API 6A performance requirement level 2 (PR-2) as detailed in Annex F of API 6A.

The wellhead system will be used for both surface (dry) tree and subsea (wet) tree applications. The system as specified should be suitable for both applications. The fatigue analysis and weak point analysis as described in Addendum A should take into account the use intended for a particular wellhead system. The fatigue analysis is greatly different for the two systems.

The wellhead systems should normally have a design service life of 25 years. This is different than that of other subsea components that typically have a 20 year life specified. The reasoning behind this difference is that in many cases the wellhead is set well in advance of the well going into production.

5.1.1.3 Materials

Add:

The product designs should be capable of functioning consistent with the materials class in API 6A and the specific requirements added by BP specifications.

Material selection should be based on GP 36-20 Specification and Selection of Materials for Subsea Equipment.

5.1.2 Service Conditions

5.1.2.1 Pressure Ratings

Add:

The design codes presently do not apply to 20,000 psi pressure ratings. The Gulf of Mexico has a qualification program underway for a 20,000 psi wellhead rated to 350 degree F.

5.1.2.1.3 Tubing Hangers - Pressure Rating

Add:



A specific requirement for the tubing hanger is that it can withstand 1.1 times the working pressure of the SCSSV line across the entire surface of the hanger due to a leak in the SCSSV line.

5.1.2.2 Temperature Ratings

Add:

The temperature range to be used for design per this document shall be +35 to 250 F upstream of the choke and -20 to 250 F downstream of the choke for 10,000 psi tree systems.

The temperature range to be used for design shall be +35 to 300 F upstream of the choke and -20 to 350 F downstream of the choke for 15,000 psi tree systems.

Add:

The 20 KSI wellhead system is designed for a temperature range of 0 to 350 degrees F.

5.1.2.3 Materials Class Ratings

Add:

The requirements of GP 36-20 Selection and Specification of Materials for Subsea Equipment apply to equipment covered by this document. The material class for all tree surfaces that are wetted by produced fluids will be HH. Surfaces not normally wetted will be class EE. Both classes are as defined in API Specification 6A.

The product designs should be capable of functioning consistent with the materials class in API 6A and the specific requirements added by BP specifications.

The material class for the production casing hanger will be "EE". The class for other wellhead system components will be "AA". The production hanger has the potential to be wetted by production so it is classed as the tree components that wetted by production.

5.1.3 Design Methods

Add:

Design will be covered in more detail in the following sections on the specific components. A detailed system analysis (see Addendum A) including fatigue analysis should be done for each installation. The analysis includes the drilling vessel, riser system, wellhead system, casing strings, tree, BOP, and environmental loadings. This will be the basis used to define the loads the wellhead system, the tree, and tree and tubing head spool connectors must withstand.

5.1.3.7 Design of Lifting Devices

5.1.3.7.2 Pad Eyes

Add:

The design of pad eyes should meet the requirements of this section and regional BP guidelines. The design factors should be compared and the more stringent should be applied. The factor of safety in API 17D/ISO 13628-4 for pad eyes is based on the ultimate tensile strength of the material while that given in some BP guidelines is based on the yield strength on the material. When a comparison is made, care must be taken that the proper material properties are used in calculations.

5.1.3.7.3 Other Lifting Devices

Add:



For lifting devices other than running tools, BP regional guidelines should be considered for the design of slings and rigging.

5.1.4.7 External Corrosion Control Program

Add:

The wellhead system corrosion protection should be designed to provide a two year life without a tree installed. The tree protection system will protect the wellhead after the tree has been installed. The protection should be provided by material selection, coatings, cathodic protection, or a combination of these elements.

5.1.4.8 External Coatings

Add:

The vendor is responsible for applying corrosion protection coatings to the tree equipment to minimize corrosion during the shipment, storage, and service life. The vendor shall propose specific coatings and provide their specifications to the company for approval. There will be a 3 part epoxy coating system applied to the tree systems.

Most wellhead components are not painted due to the tight stack-up tolerances that are required. Equipment is normally painted safety yellow with a flat, non-glare finish.

Refer to GP 06-60 Painting of Steel Surfaces for further direction on coating systems.

5.2 Materials

5.2.1 General

Add:

Detailed material requirements for the tree assembly are presented in following sections for the particular system components.

The materials of construction of pressure containing equipment including all welding shall meet the requirements of API specifications 6A, 17D PSL 3, and NACE MR0175. They are to be suitable for drilling and production in sour service conditions at full rated working pressure. The company will provide details of drilling and completions fluids so that compatibility with materials and seals used in the construction can be checked.

The supplier should list the materials of construction for all load bearing and pressure containing items including gaskets and elastomeric seals and advise the company of any special precautions that must be taken during transportation, storage, and use offshore.

5.2.2 Material Properties

Add:

All components should comply with GP 36-20.

The company shall provide the vendor with details of drilling and completions fluids so that compatibility with materials and seals used in the construction can be checked. Company should also provide details of all control fluids and chemicals to be injected through the tree.

The materials of construction of pressure containing equipment, including all welding, shall meet the requirements of ISO 13628-4/API specifications 17D, 6A PSL 3G, and NACE MR0175. They should be suitable for drilling and production in sour service conditions at full rated working pressure.



In all cases, the supplier should provide a detailed material specification based on the requirements of GP 36-20 for company approval. These should include AISI designation, chemical composition, mechanical properties (yield, tensile strengths), Charpy impact values, allowable hardness range, inlay/overlay materials, etc.

Materials exposed directly or indirectly to well fluids should be suitable for sour service environments that have H₂S partial pressures up to 4.5 psia.

Tubing hanger and tubing head spools are considered as bodies when selecting materials and setting test requirements. These are pressure containing elements, but not pressure controlling components.

5.2.3 Product Specification Level

Add:

The PSL for all valves will be PSL 3G and the rating of other components will be PSL 3.

Note that for assemblies, the PSL rating is based on the lowest individual PSL of any pressure containing/controlling component.

5.2.4 Corrosion Considerations

Add:

Refer to GP 06-10 Corrosion Management for further guidance related to corrosion control.

5.2.4.1 Corrosion from retained Fluids

Corrosion Resistant Inlays

Add:

Nickel based alloy 625 overlays on seal areas shall conform to the requirements of Section 5.3 for welding. All weld overlays on sealing surfaces should be nickel-based alloy 625 with a maximum iron content of 10% in the final pass.

Tree systems have complex geometries with several portings and dead leg areas. At a minimum, the following areas should be inlaid with nickel-based alloy 625:

- All sealing surfaces, including ring grooves, gasket preps, seat pockets, back seals, etc.
- Production flow bore.
- Valve cavities in the production flow path, including valve cavities of those valves that isolate the production flow path from other ports or cross over and swab valves.
- Dead-leg areas in production flow bore.

5.2.4.2 Corrosion from Marine Environment

Add:

The vendor is responsible for applying corrosion protection coatings to the tree equipment to minimize corrosion during the shipment, storage, and service life. The vendor shall propose specific coatings and provide their specifications to the company for approval. The tree is to be coated with a 3 part marine epoxy system following final fabrication. Refer to GP 06-60 Painting of Steel Surfaces for guidelines on coating application.



Coatings must not interfere with the interfacing of equipment components or running and intervention tools.

Material selection is the most important means of protecting the wellhead system. Most components are not painted or in some cases coated due to the stack-up tolerances as discussed earlier. Care shall be taken in the design to provide protection from corrosion during the time the wellhead is installed prior to the well being put on production. It is not uncommon for a wellhead system to be installed two years before a tree is set.

The supplier is responsible for applying corrosion protection coatings to the wellhead equipment to minimize corrosion during the shipment, storage, and service life. The supplier shall propose specific coatings and provide their specifications to the company for approval.

5.3 Welding - General Requirements

Add:

Suppliers are expected to develop and qualify Weld Procedure specifications (WPS) for all fabrication and overlay welds. WPS and supporting Procedure Qualification Records (PQR) should be submitted to the Company for approval. For certain high strength materials, the Company will recommend a WPS that is to be qualified by the Supplier.

Only weld processes approved by BP should be used in the manufacture of the wellhead or tree system. Socket welds are prohibited even for control lines.

GP 36-20 shall be the basis for all WPS developed and used.

5.3.1 Pressure Containing/Controlling Components

Add:

All components for this equipment are specified to be supplied to PSL 3G requirements.

5.3.2 Structural Components

Add:

Structural components are to be welded per the requirements of AWS D1.1 in accordance with qualified WPS; pre-qualified WPS are not acceptable.

The requirements of GP 36-20 for structural welding shall be followed.

The wellhead systems designed for deepwater applications are subjected to high environmental loadings such as Loop Currents through the riser system. At times, the currents can set up vortex induced vibrations in the riser that are transmitted into the wellhead system. Therefore, it is necessary to fabricate the structural components that resist these loadings in a manner that produces desirable fatigue resistance characteristics. Welds will be contoured for the low pressure and high pressure conductor extension joints.

5.3.3 Corrosion Resistant Inlays or Overlays

Add:

All weld overlays on sealing surfaces shall be nickel-based alloy 625 with a maximum iron content of 10% in the final pass.