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Guidance on Practice for Subsea Control Fluid Selection

GP 78-16

**BP GROUP
ENGINEERING TECHNICAL PRACTICES**

Foreword

This Guidance on Practice (GP) is the second issue of Engineering Technical Practice (ETP) BP GP 78-16 (previously numbered GP 78-20).

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Introduction

This GP is intended to assist BP project teams in the selection of a subsea control fluid for both new projects and existing assets with the overriding objective of producing reliable subsea control systems over the full life of each field. This GP provides recommendations of all aspects to be considered in initial control fluid selection for green field applications as well as guidance on management of change for brown field applications.

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1. Scope

- a. This GP provides guidance for selection of hydraulic control fluid used to transmit and deliver motive power in electrohydraulic subsea production control systems.

The subsea control fluid interfaces with all elements in the system's hydraulic circuit and has to perform satisfactorily, with no detrimental changes in either the fluid or the subsea equipment, over the full operational life of the system.

- b. Type of control fluid and subsea equipment initially selected for a project should be considered from three perspectives:
 1. Compatibility of fluid/equipment combination.
 2. Long term viability.
 3. Fluid interchangeability.
- c. This GP is applicable to all Green Field sites and for fluid change out on Brown Field sites that are operated by BP.

2. Symbols and abbreviations

For the purpose of this GP, the following symbols and abbreviations apply:

DCV	Directional control valve.
ESD	Emergency shutdown.
FAT	Factory acceptance testing.
FEED	Front end engineering design.
FPSO	Floating production, storage, and offloading.
GoM	Gulf of Mexico.
HPU	Hydraulic power unit.
IBC	Intermediate bulk containers.
OEM	Original equipment manufacturer.
OSPAR	The Convention for the Protection of the Marine Environment of the North-East Atlantic http://www.ospar.org/eng/html/welcome.html .
PPE	Personal protective equipment.
ROV	Remotely operated vehicle.
SCM	Subsea control module.
SCSSV	Surface controlled subsurface safety valve.
SIT	System integration system.
TUTU	Topside umbilical termination unit.



UKCS UK Continental Shelf.

3. Subsea control fluid selection and functional requirements

3.1. General

- a. Selected subsea control fluid shall be demonstrated to be fully compatible, over life of system, with proposed operating environment and subsea controls equipment.
- b. Subsea control fluid shall perform satisfactorily within subsea control system and have the following characteristics:
 1. Efficient transmittal of input energy through relatively long, small diameter, umbilical lines, which requires highly incompressible fluid with low viscosity over its operating temperature range.
 2. Chemical and physical stability over 20 year to 30 year lifespan if operated within its operating temperature range.
 3. Deterrence of microbiological growth over its lifespan.
 4. Acceptance of limited amounts of contamination from specific anticipated substances (e.g., lube oil, seawater, well bore acids, and downhole completion fluids) without significant changes to fluid's properties and/or formation of potentially damaging precipitates and emulsions.
 5. Compliance with all relevant legislation that determines type and quantities of chemicals that can be discharged to local marine environment.
 6. Compliance with all relevant HSE requirements such that it can be safely handled and used by operating personnel.
 7. Compatibility with all other relevant components included within overall subsea production control system and no significant deterioration to either fluid or materials in contact with fluid.
 8. Provision of acceptable lubrication properties to allow pumps and valves within control system to achieve acceptable operating lives.

The functional requirements in 1. through 8. may be subdivided into two groups:

- *First, those functional requirements limited to the fluid itself.*
- *Second, those functional requirements relating to fluid interactions with other equipment.*

- c. BP owns Castrol, a supplier of subsea control fluids. As such, projects are expected to use BP products if appropriate and acceptable to the circumstance. Specific exceptions to this shall be reviewed on a case by case basis and may include the following:
 1. Castrol products do not meet required operating environment.
 2. There is an existing incumbent fluid on a facility, and inclusion of additional fluid is deemed to add operational risk and complexity.

3.2. Temperature limitations

- a. To identify preferred subsea control fluid, candidate fluid's maximum upper operational temperature limits shall initially be determined.
- b. Other temperature limitations that shall be considered are lowest and highest temperatures that may be experienced during build, testing, and deployment.
- c. Combined effect of pressure shall also be considered.



3.3. Environmental legislation issues on control fluid selection

- a. Prior to selection of subsea control fluid, prevailing regional environmental legislation is a key point that shall be addressed, as such requirements are becoming increasingly more stringent.

The impact of environmental legislation is currently affecting OSPAR (North West European) areas and, it is anticipated, to be followed in many other areas of BP activity.

- b. Fluids compliant with new generation legislation should be specified for new developments.
- c. Full review shall be conducted prior to making any change to existing subsea control fluid.

For brown field developments, the overriding consideration will be the ongoing acceptability of current fluid in use at the tieback location.

The control fluid is a "discharged chemical" in terms of offshore legislation, even when used in a closed loop system.

It is important to note that, if the initial fluid becomes unusable at any time in the future, due to changing legislation, it may become necessary to introduce a replacement fluid into the existing system.

3.4. Material compatibility and corrosion inhibition

- a. The following material selection general rules shall be followed:
 - 1. Inherently corrosion resistant materials (preferably ferrous) shall be used, if possible.
 - 2. Combinations of different materials used in close proximity shall be carefully considered for potential galvanic corrosion.

Unprotected carbon steel surfaces will corrode if components are wetted with water based control fluids and subsequently exposed to air.

 - 3. Corrosion inhibitors may be used in control fluid.
 - 4. Vapour phase inhibitors may also be used to protect pockets where gas may collect.
- b. The following materials should be avoided:
 - 1. Materials not fully seawater resistant.
 - 2. Aluminium and aluminium alloys.
 - 3. Yellow metals (e.g., brasses and bronzes).
 - 4. Cadmium, zinc, and nickel plated surfaces (in general, all electroplated surfaces shall be avoided).
 - 5. Painted, electroless plated, or other coated surfaces.
 - 6. Cobalt bonded tungsten carbide. Nickel bonded tungsten carbides shall also be carefully considered.
- c. All subsea components shall be fully seawater tolerant.
- d. Nonmetallic components, i.e., elastomers and thermoplastic hose liners, shall be demonstrated to be fully compatible with control fluid over full anticipated service life at maximum and minimum predicted operating temperatures.

For most umbilical and SCM/Xmas Tree mounted equipment located in ambient seawater temperatures of -4 °C (25 °F) to 15 °C (59 °F), it is acceptable to perform accelerated testing at elevated temperatures. However, for downhole sealing materials, which may be operating at close to maximum allowable material/fluid



temperatures, it is recognised that accelerated temperature testing may not be possible and, hence, extended duration testing would become necessary.

- e. The following external contamination general rules shall be followed:
 1. If possible, all causes of external contamination (i.e., seawater, injected chemicals, downhole chemicals, and completion chemicals) shall be identified and avoided (or minimised).
 2. Subsea control fluid shall have inherent capability to accommodate degree of contamination while still maintaining its performance.
 3. Testing shall be included to determine tolerance to seawater and completion chemical contamination.

Seawater contamination in the control system will not initially mix. Because of differences in specific gravities, the seawater may tend to rise to the highest point possible in a local system configuration.

3.5. Control fluid lubrication and antiwear properties

Behaviour of each item of subsea equipment shall be fully qualified with specific control fluid in a test environment that is representative of service life.

A control fluid designed and manufactured in accordance with ISO 13628-6, Annex C, will exhibit, as a minimum, the extreme pressure lubrication properties inherently defined within this specification. However, it is not considered that the four ball and Falex test methods represent the mechanical process that occurs in a subsea control system.

4. New development control fluid selection and management considerations

4.1. General

- a. Selection procedure is based upon a number of suppositions and/or conclusions that are presented, with associated justifications, in the remainder of this clause.

The principal supposition in this GP is that, providing full and appropriate engineering and testing activities are performed during the design and manufacturing phases of any new development, a project can be successfully completed using any one of the currently available reputable subsea production control fluids on the market.
- b. Various factors listed in d., e., and f. define what shall be considered when selecting subsea control fluid and then subsequently managing its implementation, throughout various phases of a new development.
- c. This clause shall be read in conjunction with Appendix A, which illustrates key control fluid selection and management considerations in a graphical decision block diagram format.
- d. Control fluid interfaces shall not be restricted to equipment supplied by Controls Vendor.
- e. All topside and subsea equipment, including HPUs, Xmas Trees, SCSSVs, umbilicals, risers, manifolds, manifold isolation valves, and workover systems may all be affected, and their interfaces shall be identified and proven.
- f. Most industry standard topside equipment used on control systems (pumps, pressure regulators, relief valves, ESD valves, etc.) is accessible for maintenance and repair, enabling problems that may result from potentially changing control fluid chemistries to be managed relatively easily with little or no loss of production.



4.2. Development details**4.2.1. General**

- a. A number of basic design parameters are required for control fluid selection process, including:
 - 1. Environmental characteristics, which are project specific factors and are predetermined by the geographical location of the development.
 - 2. Other parameters, which are variables determined by high level technical evaluations performed during the development's initial conceptual and feasibility studies.
- b. Inputs from a. result in basic design parameters that have the greatest influence on the control fluid selection process.

4.2.2. Ambient environmental conditions

- a. The geographical location of a development predetermines the following key environmental conditions:
 - 1. Topside maximum and minimum temperatures that control fluid could be expected to attain while in HPU or any bulk storage reservoir in field shall be determined.
Note that, in some instances, the location's black body temperature may exceed a development's downhole reservoir temperature.
 - 2. Onshore maximum and minimum temperatures that control fluid could reasonably be expected to attain while in storage shall be determined.
 - 3. Subsea maximum and minimum temperatures shall be used to establish potential variation in control fluid's physical characteristics (primarily viscosity) and used as input in control system hydraulic analysis.
Component and/or system level testing at these temperature extremes may need to be conducted to validate system performance.
- b. Selected subsea control fluid shall always be specified to meet all surface and subsea environmental conditions. The following points are made:
 - 1. Control fluid shall have been tested by Vendor for stability and performance at temperatures at least 10°C (50°F) higher than its stated limit to provide for a safety margin and comply with industry standard specifications.
 - 2. Material compatibility aging tests should be performed at elevated temperatures to reduce required test duration.

4.2.3. SCSSV information

The surface controlled subsurface safety valve (SCSSV) maximum temperature is a key parameter in the control fluid selection process.

- a. Control fluid shall have specified operating temperature that exceeds downhole temperature.
- b. Selected subsea control fluid shall always be specified to meet all downhole environmental conditions.
SCSSV and downhole flow control devices are required to operate continuously with temperatures at or approaching the maximum downhole temperature.
- c. All qualification testing shall be fully representative of service conditions.

