

Training and Qualification of Drilling and Completion Fluids Specialists

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Introduction

The professional discipline of drilling and completion engineering is divided into subdisciplines in which technical expertise is required. One subdiscipline deals with fluids that are essential to many well construction operations—the subject of this recommended practice. For the purpose of this document, “fluids” include:

- drilling fluids,
- completion fluids,
- solids control applications.

Fluids expertise requires knowledge and skills in both engineering and chemistry. These specialized operations may not always be covered in depth by college and university engineering curricula. Individuals with technical degrees or degrees in science or engineering are well suited to be fluids professionals, although required knowledge can be gained by industry classroom and/or on-the-job training. Whether entering the subdiscipline without a formal degree as a drilling fluids specialist or with a formal degree as a drilling fluids specialist, the skills necessary to perform duties at the rig site are gained by a combination of formal classroom and practical training/experience.

This recommended practice is set out in two parts. The first part addresses the professional core skills that a drilling and completion fluids specialist, laboratory technician, or solids control technician should possess. The second part addresses more advanced skills that are required to work on more complex wells. Documents published by API Subcommittee 13 on drilling, completion, and fracturing fluids may be used as guidance for drilling and completion fluids during a well construction operation with the most relevant documents listed as normative references in [Section 2](#) and in the Bibliography. API publications may be used by anyone desiring to do so.

This recommended practice is not intended to establish certification procedures for drilling fluids personnel but is to be used for general guidance in evaluating training processes and evaluating the professional acceptability of drilling and completion fluids specialists.

Training and Qualification of Drilling and Completion Fluids Specialists

1 Scope

This recommended practice is written in two parts. The first part is a summary of basic training and knowledge that an employee or contractor shall possess to be identified as a Drilling and Completion Fluids Specialist. The first part covers basic skills as would be taught at an entry-level drilling fluids training program. The second part covers a set of advanced skills that will be required to support complex wells at the rig site. Levels of understanding for both core and advanced skills have been generally outlined, but not totally defined.

This document has been developed from a review of the curriculums that are followed by drilling fluids service companies in their basic schools and from input by industry subject matter experts. The output from this, “Professional Core Skills”, is found in [Section 5](#). Ten key professional core skill areas are identified and further broken down into topics with the knowledge expected for that topic. “Advanced Professional Skills” found in [Section 6](#) are structured in the same way and identify additional skills required to work on complex wells. Skills identified in [Section 6](#) are not taught in depth as part of basic training; rather these are additive skills attained throughout a career as a drilling and completion fluid specialist and related disciplines.

2 Normative References

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any addenda) applies.

API Recommended Practice 13B-1, *Field Testing of Water-based Drilling Fluids*

API Recommended Practice 13B-2, *Field Testing of Nonaqueous-based Drilling Fluids*

API Recommended Practice 13C, *Drilling-fluid Processing Systems Evaluation*

API Recommended Practice 13D, *Rheology and Hydraulics of Oil-well Drilling Fluids*

API Recommended Practice 13J, *Testing of Heavy Brines*

3 Terms, Definitions, Abbreviations, and Symbols

For the purposes of this document, the following definitions apply.

3.1 Terms and Definitions

3.1.1

advanced professional skills

Additional knowledge required to support complex well types obtained both by additional classroom training and field experience.

3.1.2

brine and completions operator/technician

An individual skilled in the operation, monitoring, and maintenance of oilfield brines, filtration equipment, and related tasks associated with completions.

3.1.3

drilling and completion fluids specialist

An individual with specialized knowledge of the application of drilling, workover, and completion fluids during the drilling, workover, and completion operations. He/she would typically work at the rig site on a 24-hour or drive-by

basis. The specialist could commonly have an engineering, geoscience, or other appropriate university science degree or be qualified with significant relevant experience.

NOTE Drilling and completion fluids specialists are commonly referred to as “mud man,” “mud man specialist,” “mud engineer,” “drilling fluids engineer,” “completion fluids engineer,” etc. Many countries around the world including the USA and Europe require accreditation programs to work legally as a registered engineer.

3.1.4

laboratory technician

An individual skilled in testing drilling, workover, and completion fluids in the field or the laboratory.

3.1.5

operator contractor/project specialist

A drilling and completion fluids specialist typically operating in an advisory role either at an operators office or contractors headquarters/base. The specialist will commonly have an engineering, geoscience, or other appropriate university science degree or be qualified with significant relevant experience.

3.1.6

professional core skills

The basic knowledge common to all areas of drilling workover and completion fluids technology needed by all fluids specialists to demonstrate minimum competency.

3.1.7

solids control operator/technician

An individual skilled in the operation, monitoring, maintenance, and repair of solids control equipment.

3.2 Abbreviations and Symbols

APWD	annular pressure while drilling
BOP	blowout preventer
CO ₂	carbon dioxide
ECD	equivalent circulating density
ESD	equivalent static density
H ₂ S	hydrogen sulfide
HGS	high-gravity solids
HSE	health, safety, and environment
HTHP	high temperature, high pressure
LCM	lost circulation material
LGS	low-gravity solids
MEG	mono-ethylene glycol
NADF	nonaqueous-based drilling fluid
NAF	nonaqueous fluid (base fluid)
OWR	oil/water ratio
PCT	pressurized crystallization temperature
PPA	permeability plugging apparatus
PPE	personal protective equipment.
PPT	particle plugging test.

PV	plastic viscosity (expressed in centipoises [millipascal•seconds] [cP = 1 mPa•s])
SDS	safety data sheet.
TCT	true crystalline temperature.
VSST	viscometer sag shoe test (dynamic sag test).
YP	yield point (expressed in pascals [pounds-force per 100 square feet])

4 Principle

This document is a recommended practice and seeks to provide guidance for the specific knowledge base, professional core skills, and application skills needed to ensure the competency and professionalism of individuals working in the drilling and completion fluids industry. Drilling and completion fluids technicians, specialists, and supervisors should use this document as an outline to self-determine any gaps in learning and seek to improve their skills. A company contracting the service of a drilling and completion fluids technician, specialist, or supervisor should use this recommended practice as a checklist of knowledge that they should be able to demonstrate proficiency in applying. [Table 1](#) provides a summary of professional core skill levels required by these specialists according to their function in the completion and drilling fluid industry. A summary of professional advanced core skill levels required by these specialists is provided in [Table 2](#). Additional technical references are also listed in the Bibliography.

Table 1—Drilling and Completion Fluids Specialists Professional Core Skill Levels

Core Skills	Discipline				
	Operator/ Contractor Project Specialist	Drilling and Completion Fluids Specialist	Fluids Laboratory Technician	Solids Control Operator/ Technician	Brine, Filtration, Completion Operator/ Technician
Table 3 —Rotary Rig Operations & Solids Processing	✓	✓		✓	
Table 4 —Geology and Pressure Concepts	✓	✓	✓	✓	
Table 5 —Drilling Fluid Functions	✓	✓		✓	
Table 6 —Water- based Drilling Fluids—General Knowledge	✓	✓	✓	✓	✓
Table 7 —Water- based Drilling Fluids Physical Properties	✓	✓	✓	✓	✓
Table 8 —Water- based Drilling Fluids Chemistry	✓	✓	✓		
Table 9 —Clay Chemistry	✓	✓	✓		
Table 10 —Polymer Chemistry	✓	✓	✓		
Table 11 — Nonaqueous- based Drilling Fluids—General Knowledge	✓	✓	✓	✓	✓



Documents

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Table 1—Drilling and Completion Fluids Specialists Professional Core Skill Levels (Continued)

Core Skills	Discipline				
	Operator/ Contractor Project Specialist	Drilling and Completion Fluids Specialist	Fluids Laboratory Technician	Solids Control Operator/ Technician	Brine, Filtration, Completion Operator/ Technician
Table 12 — Nonaqueous- based Drilling Fluids Properties	✓	✓	✓	✓	✓
Table 13 —Brines, Filtration and Completions	✓	✓	✓		✓
Table 14 —Oilfield Mathematics	✓	✓		✓	
Table 15 —Rheology & Hydraulics	✓	✓	✓		✓
Table 16 —Running Casing and Cementing Operations	✓	✓			
Table 17 —Lost Circulation	✓	✓	✓		
Table 18 —Wellbore Stability	✓	✓			
Table 19 —Stuck Pipe	✓	✓			
Table 20 —Well Control Operations	✓	✓			✓
Table 21 —Daily Drilling and Completion Fluids Report	✓	✓	✓		✓
Table 22 —End of Well Report and Lessons Learnt	✓	✓			
Table 23 —Logistics and Maintenance	✓	✓		✓	✓
Table 24 —Health Safety and Environment	✓	✓	✓	✓	✓
Table 25 — Interpersonal Skills	✓	✓			

Table 2—Drilling and Completion Fluids Specialists Professional Advanced Skill Levels

Core Skills	Discipline				
	Operator/ Contractor Project Specialist	Drilling and Completion Fluids Specialist	Fluids Laboratory Technician	Solids Control Operator/ Technician	Brine, Filtration, Completion Operator/ Technician
Table 26 —Surface Chemistry	✓	✓	✓		
Table 27 —Corrosion	✓	✓	✓	✓	✓
Table 28 —Deepwater	✓	✓	✓		
Table 29 —High Pressure, High Temperature (HPHT)	✓	✓	✓		
Table 30 —High-angle, Extended Reach (ERD)	✓	✓			
Table 31 —Sour Gas Wells	✓	✓	✓		
Table 32 —Reservoir Drill-In Fluids	✓	✓	✓		✓

5 Professional Core Skills

5.1 Description

This section describes the professional core skills through [Table 3](#) to [Table 25](#). Professional core skills are expected of an operator/contractor specialist/project engineer, drilling and completion fluid specialist, laboratory technician, solids control operator/technician, and brine/filtration/completion operator/technician. It is expected that these skills will be taught in an introductory drilling and completion fluids school program and that advanced skills will further be developed with rig site experience and additional training.

5.2 Drilling Rig, Geology, and Drilling Fluid Functions (Tables 3 to 5)

Table 3a—Rotary Rig Operations and Solids Processing: Rotary Drilling Rig

Task and Knowledge Assessment: Basic Understanding of the Rotary Drilling Rig	
Topic	Knowledge or Task
Rotary drilling operations	Understands: — the main components of a rotary drilling rig and their function; — the rotary drilling process and typical rig operations; — the job functions of the rig crew and supervisory personnel; — the role of typical rig site service company support personnel
Circulating system and other surface equipment	Understands: — the components of a rotary drilling circulating system; — the layout and various flow paths of the circulating system; — the high-pressure and low-pressure circulating systems; — the difference between and the general applications of positive displacement and centrifugal pumps; — the function of the mud gas separator and vacuum degasser; — the function, setup, and operation of a chemical (mixing) hopper, liquid additive system, big bag mixing hopper and/or automatic online sack mixing device; — the use and function of a drilling fluid shearing device; — the use of a caustic soda mixing drum and the related safety precautions; — the various types of pit agitation systems (circulation, agitation, mud guns, etc.) and differences and utilization issues.

Table 3b—Rotary Rig Operations and Solids Processing: Solids Processing

Task and Knowledge Assessment: Basic Understanding of Solids Control Equipment and Drilling Fluids Processing	
Topic	Knowledge or Task
Solids control equipment	Understands: - the particle size of different rock types and the capabilities of different types of solids control/removal equipment to remove it; - which equipment or mechanism (chemical/ dilution) to use to remove gumbo, coarse drilled solids, fine drilled solids, high-gravity drill solids, low-gravity drill solids, suspended drill solids, dissolved drill solids; - The equipment includes: - gumbo conveyor and gumbo trap removal systems, - the sand traps, - the settling pits, - shale shaker and/or nonvibrating rotating screens, - desander, desilter, and mud-cleaner, - decanting centrifuge and other types of centrifuge, - cuttings dryer, - cartridge and diatomaceous earth filtration devices, and - flocculation units. - the difference between desirable solids and undesirable solids; - the proper flow path for fluid-handling and processing equipment under different rig site/mud plant conditions or requirements; - the function and operation of the shale shakers including: - optimum solid removal is always accomplished by the first pass over the shale shakers; - circular/linear/balanced elliptical motion; - single/multiple decks screen configuration and optimization. - the API screen number and the various elements of the API shaker screen designation system and labeling; - how to select shale shaker screens to maximize solids removal efficiency; - how high API screen numbers affect drilling-fluid to drilled-solids ratio; - the importance of shaker screen and frame maintenance and typical maintenance items; - the application and function of desanders, desilters, and mud cleaners, and their likely cut points; - how to observe efficient/inefficient hydrocyclone operation; - the function of a drilling fluid decanter centrifuge and its typical cut point range; - the key metrics used to evaluate centrifuge performance: - feed rate; - scroll rpm; - bowl rpm; - pond depth; - residence time; - torque limits; - slurry viscosity/density/concentration/ cuttings shape/cuttings hardness; - bowl inside diameter; - bowl length; - gearbox ratio; - electric drive and back-drive motor size; - feed pump type and performance. - the importance of centrifuge maintenance. Able to describe: - importance of automatic safety features for centrifuges; - the effects of fluid viscosity, density, and feed rate on solids-control equipment performance; - an assessment methodology (solids control equipment audit) for a rig-based solids control system; - application for dewatering and basic dewatering technique.

Table 3b—Rotary Rig Operations and Solids Processing: Solids Processing (Continued)

Task and Knowledge Assessment: Basic Understanding of Solids Control Equipment and Drilling Fluids Processing	
Topic	Knowledge or Task
Solids removal efficiency and drilling-fluid to drilled-solids ratio	Understands: — the difference between dilution and solids control; — the economic considerations associated with solids control; — how to calculate the solids-control equipment processing rate versus fluid system circulating rate; — solids removal efficiency and its effect on volume of drilling fluid required at the rig site; — the effect that the low-gravity solids (LGS) concentration at which a drilling fluid system is maintained has on the volume of drilling fluid required. Able to describe: — what the drilling fluid to drilled-solids ratio represents; and — the relationship between size of cuttings and retention on cuttings due to increasing surface area to volume with decreasing particle size.
Main solids processing knowledge or tasks shall refer to API 13C.	

Table 4—Geology and Pressure Concepts

Task and Knowledge Assessment Categories: Basic Understanding of Geological Conditions	
Topic	Knowledge or Task
Rock types and pressure	Understands: — common sedimentary rock types and their potential to contaminate the drilling/completion fluid; — the fundamentals of: — porosity; — permeability; — pore throat openings; — overburden gradient and how it is derived; — geothermal gradient; — hydrostatic pressure concepts; — fracture gradient; — pore pressure and methods of abnormal pressure detection; — relative differences in pore size and permeability between sandstone and shale and how this may relate to desirable drilling fluid properties.

Table 5—Drilling Fluids Functions

Task and Knowledge Assessment: Knowledge of the Functions of Drilling Fluids	
Topic	Knowledge or Task
Remove cuttings	Understands the importance of carrying capacity, annular velocity, slip velocity, and annular viscosity in the hole cleaning process. Able to describe rheological properties of a drilling fluid and their effect on standpipe pressure and equivalent circulating density (ECD).
Suspend and release cuttings	Understands the balance between the rheological properties of a drilling fluid that will suspend drilled cuttings in the annulus, yet allow drilled cuttings to be efficiently removed from the fluid by the shale shakers at the surface. Able to identify lack of suspension properties and able to suggest measures to improve suspension properties as needed.
Suspend weight material	Understands the rheological parameters necessary to provide both static and dynamic weight material suspension.
Control formation pressures	Understands hydrostatic pressure and formation pressure and can describe their role in preventing formation fluids from entering the wellbore. Able to calculate hydrostatic pressure of the fluid system.
Maintain wellbore stability	Understands how the chemical composition and physical properties of a drilling fluid affect wellbore stability in various types of geological formations.
Seal permeable formations	Understands: — the role and characteristics of filter cake required to minimize fluid penetration into permeable formations; — the general approach for the management and control of drilling fluid filtration rate.
Minimize formation damage	Understands: — the needs for drilling fluids to be minimally damaging to the reservoir; — the difference between solids invasion and filtrate invasion and how these may affect the formation. Able to propose measures to optimize filter cake and minimize formation damage.
Cool and lubricate the drilling bit	Understands the role of drilling fluids in minimizing friction and cooling of the bit.
Transmit hydraulic energy to downhole tools	Understands the role of drilling fluids to transmit the force needed to operate downhole tools.
Facilitate formation evaluation	Understands that the chemical formulation of a drilling fluid can affect evaluation by wireline logs.
Control corrosion	Understands: — the physical and chemical characteristics of drilling fluids that can create corrosive environments; — the effect that dissolved solids and gasses sourced from the formation or chemical/thermal decomposition of additives have on the corrosion potential of the drilling fluid.

5.3 Water-based Drilling Fluids (Tables 6 to 10)

Table 6—Water-based Drilling Fluids: General Knowledge

Task and Knowledge Assessment: General Knowledge of Water-based Drilling Fluids	
Topic	Knowledge or Task
Basic drilling fluid additives	Understands the use, advantages, and disadvantages of the various drilling fluid additives.
Fundamentals	Understands the uses, advantages, and disadvantages of the following: — simple systems such as spud fluids, clear-water fluids, and native fluid systems; — noninhibited/dispersed systems; — low solids, nondispersed systems; — polymer systems; — inhibited/nondispersed systems; — high-temperature, high-pressure (HTHP) systems; — reservoir drill-in systems.
Formulations	Understands: — the basic formulations of the following systems: — spud muds; — noninhibited/dispersed systems; — low solids, nondispersed systems; — polymer systems; — inhibited/nondispersed systems; — HTHP systems; — reservoir drill-in systems. — the preferred mixing order of chemical additions, including the importance/benefit of this preferred order of addition. Able to write a rig site mixing procedure, including order of addition, mixing speed, and mixing time for the various types of fluid.
Contamination	Able to: — identify common water-based drilling fluid contaminants and their effect on drilling fluid properties; — minimize contamination by pre-treatment; — propose and execute treatment of common contaminants such as solids, cement, carbonates, salt and acid gases etc.
Pilot testing	Understands the skills required for pilot testing and to propose optimization and treatment of water-based drilling fluids. Able to use the pilot testing equipment and has knowledge of the necessary equipment.