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Petroleum and natural gas industries — Drilling and production equipment — Shallow gas diverter equipment

Industries du pétrole et du gaz naturel — Équipements de forage et de production — Équipement déflecteur pour gaz de surface

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Contents

Page

Foreword

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The committee responsible for this document is ISO/TC 67, *Petroleum and Natural gas industries*, Subcommittee SC 4, *Drilling and production equipment*.

Introduction

Drilling into shallow-gas-bearing formations is a very delicate and challenging operation. If the drilling operations are seriously complicated by the reduced safety margin available between kick and loss, the situation in case of a gas influx becomes extremely hazardous, due to a combination of the following adverse factors.

— Shallow gas flows are extremely fast-developing events; there is only a short transition time between influx detection and well unloading, resulting in a reduced time for the driller to take the right decision, and leaving little room for error.

— Past blowout reports have disclosed the magnitude of severe dynamic loads applied to surface diverting equipment. One of the associated effects is erosion, which adds a high potential for fire and explosion due to flow impingement on rig facilities which gives the gas flow access to various sources of ignition.

— Many past shallow-gas kicks turned into uncontrolled blowouts due to the failure of former diverter systems installed several decades ago. Failure is seen as a result of the system's complexity, its lack of functional reliability and its inability to cope with the severe dynamic loads.

— Certain drilling supports are exposed to specific threats associated with shallow gas blowouts, e.g. risk of cratering, risk of ship-shaped vessel capsize.

— Unprepared or inadequately trained drilling crews experience a high level of stress when facing a violent shallow gas flow.

In the aftermath of shallow gas blowouts during the last four decades, comprehensive inquiries and reports have been carried out, in particular by the specialists involved in combating these events, and significant findings and conclusions have been published. In the meantime, the manufacturing industry has developed various equipment aimed at significantly improving the safety of shallow-gas drilling operations.

This International Standard has been prepared taking these aspects into consideration.

Petroleum and natural gas industries — Drilling and production equipment — Shallow gas diverter equipment

1 Scope

This International Standard specifies requirements for the selection of the diverter equipment for rigs used to drill shallow-gas-bearing formations. It covers both onshore and offshore drilling operations, and considers also the auxiliary equipment associated with floating rigs.

The specified requirements concern the following diverter equipment:

— annular sealing devices;

— vent outlets;

— diverter valves;

— diverter piping.

This International Standard highlights the concerns associated with the selection of a marine floating drilling support. It covers safety issues concerning key rig equipment, and important steps of action required prior to starting the drilling operations.

It provides only general guidelines regarding the response to be given to a shallow-gas flow.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 13533, *Petroleum and natural gas industries — Drilling and production equipment — Drill-through equipment*

API 16D (latest revision), *Specification for Control Systems for Drilling Well Control Equipment and Control Systems for Diverter Equipment*

3 Terms and definitions

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

3.1
actuator
device used to open or close a valve by means of applied manual, hydraulic, pneumatic or electrical energy

3.2
annular packing element
doughnut-shaped rubber/elastomer element that creates a seal in an annular preventer or diverter

Note 1 to entry: The annular packing element is displaced toward the bore centre by the upward movement of an annular piston.

3.3
annular sealing device
torus-shaped steel housing containing an annular packing element which facilitates closure of the annulus by constricting to seal on the pipe or kelly in the wellbore

Note 1 to entry: Some annular sealing devices also facilitate shutoff of the open hole.

3.4
bag preventer
device that can seal around any object in the wellbore or upon itself

Note 1 to entry: Compression of a reinforced rubber/elastomer packing element by hydraulic pressure creates the seal.

3.5
ball valve
valve that employs a rotating ball to open or close the flow passage

3.6
blowout
uncontrolled flow of well fluids and/or formation fluids from the wellbore or into lower-pressured subsurface zones

Note 1 to entry: When the uncontrolled flow of fluids goes into lower-pressured subsurface zones, it is termed an underground blowout.

3.7
blowout preventer stack
BOP stack
device that allows the well to be sealed to confine the well fluids in the wellbore

3.8
bottom-supported marine structure
drilling structure supported by the soil on the seabed while in the operating mode

Note 1 to entry: Rigs of this type include fixed platforms, submersibles, swamp barges and jack-up drilling rigs.

3.9
cleanout
point in the flow-line piping where the internal area of the pipe can be accessed to remove accumulated debris and drill cuttings

3.10
closing unit
assemblage of pumps, valves, lines, accumulators and other items necessary to open and close the BOP equipment and diverter system

3.11
control function
control system circuit (hydraulic, pneumatic, electrical, mechanical, or a combination thereof) used to operate the position selection of a diverter unit, BOP, valve or regulator

EXAMPLE Diverter “close” function, starboard vent valve “open” function.

3.12
control function
each position of a diverter unit, BOP or valve and each regulator assignment that is operated by the control system

3.13
diverter
device attached to the wellhead or marine riser to close the vertical access and to direct any flow into a set of vent lines and away from the drilling unit

3.14
diverter control system
assemblage of pumps, accumulators, manifolds, control panels, valves, lines, etc., used to operate the diverter system

3.15
diverter housing
permanent installation under the rotary table which houses the insert-type diverter assembly

3.16
diverter packer
annular sealing device of the diverter

3.17
diverter piping
vent lines of the diverter

3.18
diverter system
assemblage, comprising an annular sealing device, flow control means, vent system components and control system, which facilitates closure of the upward flow path of the well fluid and opening of the vent to the atmosphere

3.19
diverter unit
device that embodies the annular sealing device and its actuating means

3.20
drill floor substructure
foundation structure on which the derrick, rotary table, draw-works and other drilling equipment are supported

3.21
drilling spool
flanged joint placed between the BOP and casing-head that serves as a spacer or crossover

3.22
drill ship
self-propelled, floating, ship-shaped vessel equipped with drilling equipment

3.23
dump valve
device used to control bottom-riser annulus pressure by establishing direct communication with the sea

3.24
dynamically positioned drilling vessel
DP drilling vessel
drill-ship or semi-submersible drilling rig equipped with computer-controlled thrusters which enable it to maintain a constant position relative to a fixed point on the sea floor without the use of anchors and mooring lines while conducting floating drilling operations

3.25
elastomer
any of various elastic compounds or substances resembling rubber

3.26
fill-up line
line, usually connected into the bell nipple above the BOP, to allow addition of drilling fluid to the hole while simultaneously pulling out of the hole to compensate for the metal volume displacement of the drill string being pulled

3.27
flex/ball joint
device installed directly above the subsea BOP stack and at the top of the telescopic riser joint to permit relative angular movement of the riser, thus reducing stresses due to vessel motions and environmental forces

3.28
flow-line
shaker line
piping that exits the bell nipple and conducts drilling fluid and cuttings to the shale shaker and drilling fluid pits

3.29
formation fracture pessure
value of pressure required to initiate a fracture in a subsurface formation (geologic strata)

3.30
function test
closing and opening (cycling) equipment to verify operability

3.31
gate valve
valve that employs a sliding gate to open or close the flow passage

3.32
hydrostatic head
true vertical length of fluid column

3.33
hydrostatic pressure
pressure that exists at any point in the wellbore due to the weight of the vertical column of fluid above that point

3.34
inner barrel
part of the telescopic slip joint on a marine riser that is attached to the flex joint beneath the diverter

3.35
insert-type packer
diverter element that uses inserts designed to close and seal on specific ranges of pipe diameter

3.36
integral valve
valve embodied in the diverter unit that operates integrally with the annular sealing device

3.37
interlock
arrangement of control system functions designed to require the actuation of one function as a prerequisite to actuate another

3.38
kelly
joint of pipe with flat or fluted sides that is free to move vertically through a bushing in the rotary table

Note 1 to entry: The bushing is termed a “kelly bushing”, and it imparts torque to the kelly thereby rotating the drill string.

3.39
kick
influx of gas, oil or other well fluids which, if not controlled, can result in a blowout

3.40
kill mud
drilling fluid with sufficient mud weight used to overcome the borehole pressure in case of well influx

3.41
knife valve
valve using a portal plate or blade to facilitate open and close operations

Note 1 to entry: A knife valve differs from a gate valve in that the bonnet area is open, i.e. not sealed.

3.42
lost circulation
loss of drilling fluid to the wellbore

3.43
marine riser
extension of the well-bore from the subsea conductor pipe housing or wellhead to the floating drilling vessel which provides for fluid returns to the drilling vessel and guides tools into the well

3.44
moored vessel
offshore floating drilling vessel which relies on anchors, chain and mooring lines extended to the ocean floor to maintain a constant location relative to the ocean floor

3.45
mud line
floor of an ocean, lake, bay or swamp

3.46
outer barrel
part of the telescopic slip joint on a marine riser that is attached to tensioner lines

Note 1 to entry: Tension is transferred through the outer barrel into the riser.

3.47
pre-spud
period of time which precedes the start of drilling activities

3.48
poor-boy separator
pressure vessel designed to provide effective separation of gas from drilling fluid at atmospheric pressure while circulating out a wellbore kick through the choke manifold

3.49
primary well control
prevention of formation fluid flow by maintaining a hydrostatic pressure equal to or greater than the formation pressure

3.50
production platform
permanently installed bottom-supported/connected offshore structure, fitted with drilling and/or production equipment for drilling and/or development of offshore oil and gas reservoirs

3.51
riser hydraulic connector
hydraulic latch which connects the 762 mm (30 in) conductor pipe housing and the bottom of the marine riser

Note 1 to entry: O-ring seals prevent leaks between the latch and the housing.

3.52
rotary table
device through which the bit and drill string pass and which transmits rotational action to the kelly

3.53
subsea diverter
seabed diverter
set-up of equipment attached to the bottom of the marine riser and connected to the 762 mm (30 in) subsea wellhead housing, designed to close the well in case of shallow-gas influx and to direct it through two subsea lateral vent outlets

3.54
semi-submersible
floating offshore drilling vessel which is ballasted at the drilling location and conducts drilling operations in a stable, partly submerged position

3.55
target
bull plug or blind flange at the end of a tee to reduce erosion at a point where change in flow direction occurs

3.56
targeted
having a type of fluid piping system in which flow impinges upon a lead (or other material)-filled end (target) or a piping tee when the fluid flow changes direction

3.57
telescopic joint packer
torus-shaped, hydraulically, pneumatically or mechanically actuated, resilient element between the inner and outer barrels of the telescopic joint which serves to retain drilling fluid inside the marine riser

3.58
vent line
conduit that directs the flow of diverted wellbore fluids away from the drill floor and to the atmosphere

3.59
vent line valve
full-opening valve which allows passage of diverted wellbore fluids through the vent line

3.60
vent outlet
point at which fluids exit the wellbore below the annular sealing device via the vent line

3.61
wellhead
apparatus or structure, placed on the top of the casings, that supports the internal tubular, seals the well and permits access to the casing annulus

3.62
working pressure rating
WP rating
maximum internal pressure that the equipment is designed to contain or control

4 Diverter system equipment

4.1 General purpose

The diverter system is designed to permit the drilling crew to blow down shallow-gas accumulations downwind of the rig. Until a sufficient casing length has been set to allow a well to be shut-in during a kick, the diverter system is the only line of defence, and is only expected to contain the hazard temporarily, although as long as possible.

The diverter system is not intended to be a well-control device. It simply allows the flow to be diverted in a safe manner in order to allow enough time to attempt regaining primary control of the well and, should the latter fail, enough time for proper evacuation of the drilling crew or for proper move-off of the drilling unit from the location (floating rigs), until the flow stops due to gas accumulation blow-down, hole bridging, hole collapse, etc.

Traditional diverter system components comprise:

— the annular sealing device;

— vent outlet(s) and vent line(s);

— valves;

— the control system.

4.2 Findings of blowout reports

Blowout inquiries have concluded that the original designs underestimated the fact that shallow-gas blowouts produce huge amounts of gas, together with abrasive solids, flowing at very high speed, producing severe dynamic loads, and eroding and destroying many parts of the existing diverter systems.

The failure of these diverter systems led unfortunately to the loss of many lives.

It is therefore of paramount importance to select suitable equipment able to function in a reliable and safe manner, i.e. able to operate whenever required under the worst possible conditions. Diverter equipment shall also be able to cope with the prevailing dynamic loads and associated effects.

The most frequent findings from blowout reports are as follows.

— Insert-type diverters have too many components.

— The locking mechanism of insert-type diverters is not really designed to contend with severe dynamic loads.

— Insert-type diverter packers cannot close on open-hole and on some drilling assemblies.

— Piston-actuated bag preventers are stronger and less complex, but close too slowly.

— Diverter outlets often promote erosion.

— Diverter vent lines are usually thin-walled, too small in diameter, have a tortuous path, and are inadequately supported, fastened and secured.

— Some valve systems are inadequate and unreliable.