

Recommended Practice for Well Control Operations

API RECOMMENDED PRACTICE 59
SECOND EDITION, MAY 2006

REAFFIRMED, MAY 2023



American
Petroleum
Institute

SPECIAL NOTES

API publications necessarily address problems of a general nature. With respect to particular circumstances, local, state, and federal laws and regulations should be reviewed.

Neither API nor any of API's employees, subcontractors, consultants, committees, or other assignees make any warranty or representation, either express or implied, with respect to the accuracy, completeness, or usefulness of the information contained herein, or assume any liability or responsibility for any use, or the results of such use, of any information or process disclosed in this publication. Neither API nor any of API's employees, subcontractors, consultants, or other assignees represent that use of this publication would not infringe upon privately owned rights.

API publications may be used by anyone desiring to do so. Every effort has been made by the Institute to assure the accuracy and reliability of the data contained in them; however, the Institute makes no representation, warranty, or guarantee in connection with this publication and hereby expressly disclaims any liability or responsibility for loss or damage resulting from its use or for the violation of any authorities having jurisdiction with which the publication may conflict.

API publications are published to facilitate the broad availability of proven, sound engineering and operating practices. These publications are not intended to obviate the need for applying sound engineering judgment regarding when and where the publications should be utilized. The formulation and publication of API publications is not intended in any way to inhibit anyone from using any other practices.

Any manufacturer marking equipment or materials in conformance with the marking requirements of an API standard is solely responsible for complying with all the applicable requirements of that standard. API does not represent, warrant, or guarantee that such products do in fact conform to the applicable API standard.

All rights reserved. No part of this work may be reproduced, stored in a retrieval system, or transmitted by any means, electronic, mechanical, photocopying, recording, or otherwise, without prior written permission from the publisher. Contact the Publisher, API Publishing Services, 200 Massachusetts Avenue, NW, Washington, DC 20001.

FOREWORD

This publication is under jurisdiction of the American Petroleum Institute, Upstream Department's Executive Committee on Drilling and Production Operations.

Drilling and well service unit (production well service, well workover, well completion, and plug and abandonment) operations are being conducted with full regard for personnel safety, public safety, and preservation of the environment in such diverse conditions as metropolitan sites, wilderness areas, ocean platforms, deepwater sites, barren deserts, wildlife refuges, and arctic ice packs. Recommendations presented in this publication are based on extensive and wide-ranging industry experience.

The goal of this voluntary recommended practice is to assist the oil and gas industry in promoting personnel and public safety, integrity of the drilling and well service equipment, and preservation of the environment for land and marine drilling and well service operations. This recommended practice is published to facilitate the broad availability of proven, sound engineering and operating practices. This publication does not present all of the operating practices that can be employed to successfully install and operate well control systems in drilling and well service operations. Nor does this publication imply that all of the practices herein are applicable to all drilling and well service operations. Drilling and well service operations throughout the world vary widely and take place under a wide range of downhole and surface conditions. Practices at one operation will not necessarily be required at a similar operation due to different conditions. Practices set forth herein are considered acceptable for accomplishing the job as described; equivalent alternative installations and practices may be utilized to accomplish the same objectives. Individuals and organizations using these recommended practices are cautioned that operations must comply with requirements of national, state, or local regulations. These requirements should be reviewed to determine whether violations may occur.

Users of recommendations set forth herein are reminded that constantly developing technology and specialized or limited operations do not permit complete coverage of all operations and alternatives. Recommendations presented herein are not intended to inhibit developing technology and equipment improvements or improved operational procedures. These recommended practices are not intended to obviate the need for qualified engineering and operations analyses and sound judgment as to when and where these recommended practices should be utilized to fit a specific drilling application.

This publication includes use of the verbs shall and should, whichever is deemed most applicable for the specific situation. For the purposes of this publication, the following definitions are applicable:

Shall—Indicates that the recommended practice(s) has universal applicability to that specific activity.

Should—Denotes a recommended practice(s) a) where a safe comparable alternative practice(s) is available; b) that may be impractical under certain circumstances; or c) that may be unnecessary under certain circumstances or applications.

Changes in the uses of these verbs are not to be effected without risk of changing the intent of recommendations set forth herein.

Nothing contained in any API publication is to be construed as granting any right, by implication or otherwise, for the manufacture, sale, or use of any method, apparatus, or product covered by letters patent. Neither should anything contained in the publication be construed as insuring anyone against liability for infringement of letters patent.

This document was produced under API standardization procedures that ensure appropriate notification and participation in the developmental process and is designated as an API stan-

ard. Questions concerning the interpretation of the content of this publication or comments and questions concerning the procedures under which this publication was developed should be directed in writing to the Director of Standards, American Petroleum Institute, 200 Massachusetts Avenue, NW, Washington, DC 20001. Requests for permission to reproduce or translate all or any part of the material published herein should also be addressed to the director.

Generally, API standards are reviewed and revised, reaffirmed, or withdrawn at least every five years. A one-time extension of up to two years may be added to this review cycle. Status of the publication can be ascertained from the API Standards Department, telephone (202) 682-8000. A catalog of API publications and materials is published annually and updated quarterly by API, 200 Massachusetts Avenue, NW, Washington, DC 20001.

Suggested revisions are invited and should be submitted to the Standards and Publications Department, API, 200 Massachusetts Avenue, NW, Washington, DC 20001, standards@api.org.

CONTENTS

	Page
1 SCOPE.....	1
1.1 Purpose.....	1
1.2 BOP Installations.....	1
1.3 Operations.....	1
1.4 Furthering the Understanding of Well Control.....	1
1.5 Deepwater.....	1
2 REFERENCES.....	1
2.1 Standards.....	1
2.2 Other References.....	2
3 GLOSSARY FOR WELL CONTROL OPERATIONS.....	2
3.1 Definitions.....	2
3.2 Acronyms and Abbreviations.....	6
4 PRINCIPLES OF WELL CONTROL.....	6
4.1 General.....	6
4.2 Conventions.....	6
4.3 Primary Well Control.....	7
4.4 The Flowing Well.....	7
4.5 Drilling or Workover Fluid.....	9
4.6 Influx Behavior.....	10
4.7 Formation Integrity Tests.....	10
4.8 Well Control Pressures.....	11
4.9 Well Close-in Procedures.....	14
4.10 Methods For Circulating Kicks At Constant Bottom-Hole Pressure.....	15
4.11 Non-Circulation Kill Methods.....	23
4.12 Comparison of Kill Methods.....	25
4.13 Choke Line Pressure—Subsea Stacks.....	26
4.14 Diverter System Applications.....	31
4.15 Well Control Worksheets.....	31
5 CAUSES OF KICKS.....	32
5.1 Conditions Necessary for a Kick.....	32
5.2 Insufficient Hydrostatic Pressure.....	32
5.3 Drilling Into an Adjacent Well.....	33
6 WELL CONTROL WARNING SIGNALS.....	33
6.1 General.....	33
6.2 Gain in Pit Volume.....	33
6.3 Increased Flow from Annulus.....	33
6.4 Volume of Drilling Fluid to Keep the Hole Full on a Trip is Less Than Calculated or Less Than Trip Book Record.....	33
6.5 Sudden Increase in Bit Penetration Rate.....	34
6.6 Change in Pump Speed or Pressure.....	34
6.7 Flow After Pumps Stopped.....	34
6.8 Gas-cut Drilling Fluid.....	34
6.9 Liquid-cut Drilling Fluid.....	35

CONTENTS

	Page
7 WELL PLANNING	35
7.1 Introduction	35
7.2 Data Availability and Gathering	35
7.3 Shallow Flows	36
7.4 Casing	37
7.5 Cementing	37
7.6 Blowout Prevention Equipment Selection	37
7.7 Drilling Fluid	38
7.8 Service Operations	38
7.9 Kick Response Plans	39
7.10 Riser Disconnect	39
7.11 Simultaneous Operations	39
7.12 Logistics	39
7.13 Safety and Medical	40
7.14 Communication	40
7.15 Training and Instruction	40
8 WELL CONTROL PROCEDURES FOR SURFACE DIVERTER INSTALLATIONS	41
8.1 Purpose	41
8.2 Installation of Equipment	41
8.3 Diverter Operation	41
8.4 Diverter Stripping Operations	42
9 CONTROL PROCEDURES—SURFACE BOPS	42
9.1 Pre-kick Planning	42
9.2 Well Control Procedures	43
9.3 Drill String Off-bottom	44
9.4 High-Angle and Horizontal Well Bores	45
9.5 Reference Notes for Section 9	45
10 WELL CONTROL PROCEDURES FOR SUBSEA BOPS	46
10.1 General	46
10.2 Additional Causes of Kicks Unique to Subsea Operations	46
10.3 Subsea Exceptions to Control Procedures	46
10.4 Special Subsea Procedures	47
11 WELL CONTROL PROCEDURES—RECOMMENDED RIG PRACTICES	48
11.1 Well Control System Equipment Installation	48
11.2 Well Control Equipment Installation Test	49
11.3 Crew Drills	49
11.4 Trip Tanks	50
11.5 Gas-Cut Drilling Fluid	50
11.6 Trip Book	50
11.7 Pre-Kick Information	52
11.8 Minimize Time Out of the Hole	52
11.9 Trip Margin	52
11.10 Short Trip	52
11.11 Rig Practices for Handling Pressure	54

CONTENTS

	Page
11.12 Rig Practices for Pipe Handling	54
11.13 Drill Stem Tests	54
12 PROCEDURES FOR DEALING WITH SPECIAL PROBLEMS	54
12.1 Introduction	54
12.2 Pump Failure in a Kick Situation	55
12.3 Excessive Casing Pressure	55
12.4 Pipe Problems with a Well Kick	56
12.5 Procedures for Gas Bubble Migration	59
12.6 Gas Influx In Cemented Annulus	59
12.7 Drill Stem Testing	60
12.8 Stripping Procedures	60
12.9 Bullheading and Top Kill Methods	61
13 SLURRIES AND PLUGS TO DEAL WITH LOST CIRCULATION AND UNDERGROUND BLOWOUTS	61
13.1 Introduction	61
13.2 Lost Circulation	61
13.3 Underground Blowouts	61
13.4 Barite Plugs	62
13.5 Squeeze Slurries	64
APPENDIX A KICK PRESSURE AND GRADIENT CALCULATIONS	67
APPENDIX B WELL CONTROL WORKSHEETS	77
Figures	
4.1 Example of Primary Well Control Conditions	7
4.2 Well Performance	8
4.3 Equipment Performance Relationship	8
4.4 Equipment & Well Performance Curves	8
4.5 Dynamic Kill	8
4.6 Static Wellbore Pressures	12
4.7 Equivalent Circulating Density	13
4.8 Well Closed-In on a Kick	14
4.9 Closed-In Drill Pipe Pressure	14
4.10 Gas Influx Migrating Up The Hole	15
4.11 Stabilized Pumping of A Kick	17
4.12 Casing Pressure And Gas Volume Resulting From Using The Driller's Method	19
4.13 Casing Pressure and Gas Volume Using the Driller's Method	20
4.14 Drill Pipe Pressure Schedule for the Wait and Weight Method	21
4.15 Typical Casing Pressure Resulting from Using Wait and Weight Method	22
4.16 Drill Pipe Pressure Schedule-Concurrent Method	24
4.17 Typical Casing Pressure Resulting From Using Concurrent Method	25
4.18 Example Of Approximate Casing Pressures With Different Kill Methods	27
4.19 Pressure Loss versus Flow Rate	28
4.20 Pressure Loss through Choke Line and Manifold With Choke Full Open	29
11.1 Loss of Effective Drilling Fluid Density Due to Gas Cut	51
A.1 Weight of a Gas Kick, 0.6 Gravity Gas	69
A.2 Maximum Surface Pressure of A Zero Intensity Gas Kick	70

CONTENTS

	Page
A.3 Factor for Determining the Maximum Surface or Casing Shoe Pressure while Killing a Gas Kick with a Constant Bottom-Hole Pressure Method	71

Tables

11.1 Example Form from a Trip Book	53
12.1 Indicators of Possible Problems while Circulating Out a Kick	57
13.1 Barite Slurry Formulations	62
13.2 Slurry Volumes	63
13.3 Barite Required (API Barite Specific Gravity = 4.20)	63
13.4 Diesel Oil-Bentonite Drilling Fluid Reactive Slurries	63
13.5 Trial Mixing Ratios for Reactive Slurry Mixtures	65
13.6 Materials Quantities for Mixing One Barrel of HWL-HS Cement Slurry	66

Currently in preview, click buy full version

Recommended Practice for Well Control Operations

1 Scope

1.1 PURPOSE

The purpose of these recommended practices is to provide information that can serve as a voluntary industry guide for safe well control operations. This publication is designed to serve as a direct field aid in well control and as a technical source for teaching well control principles. This publication establishes recommended operations to retain pressure control of the well under pre-kick conditions and recommended practices to be utilized during a kick. It serves as a companion to API RP 53, *Recommended Practice for Blowout Prevention Equipment Systems for Drilling Wells* and API RP 64 *Recommended Practice for Diverter Systems Equipment and Operations* (reader should check for the latest edition). RP 53 establishes recommended practices for the installation and testing of equipment for the anticipated well conditions and service and RP 64 establishes recommended practices for installation, testing, and operation of diverters systems and discusses the special circumstances of uncontrolled flow from shallow gas formations.

1.2 BOP INSTALLATIONS

The recommended practices are separated into two main systems:

1. Blowout preventers (BOPs) at the surface within reach and sight of the driller or well service unit operator, and
2. BOPs installed on the seafloor with relatively long choke and kill lines.

In this publication, sections have been prepared to establish practices and procedures pertaining to both surface BOP installations and subsea BOP installations. The delineation between surface BOP installations and subsea BOP installations is mainly on an exception basis, and the recommendations made for surface installations apply to subsea installations unless exceptions are stated. The recommended practices can apply to drilling, well service unit, and coiled tubing unit operations. The fundamentals of well flow and well control are the same.

1.3 OPERATIONS

This publication was developed to enhance well control by proper planning and execution and thus avoid a kick. The publication also deals with the eventuality that a well kick may occur and presents details for handling such a kick using basic control methods. Details of these basic control methods are presented for both surface and subsea BOP stack installations. Suggested considerations and modifications to the basic control methods, which may be dictated by special problems or well conditions, are also covered. Recommended

well control worksheets for surface and subsea BOP installations are included in Appendix B. Instructions are included for completing and use of the well control worksheets. Recommended practices set forth in this publication are considered adequate to meet specified well conditions. It is recognized that there are alternate procedures that can be utilized in well control that may be equally as effective in meeting the well requirements and promoting safety and efficiency.

1.4 FURTHERING THE UNDERSTANDING OF WELL CONTROL

Details of well control techniques and reasons for the recommended procedures are included in Section 4, "Principles of Well Control." Section 4 was prepared so it can be used as a technical base for instructing personnel in well control operations. Appendix A contains several special pressure and pressure gradient calculations and examples to further emphasize the techniques and calculations that can aid a well control supervisor in understanding well control operations.

1.5 DEEPWATER

The International Association of Drilling Contractors (IADC) has published guidelines for planning and drilling deepwater wells, IADC Deepwater Well Control Guidelines, 1998 Edition. The reader is referred to that document for more complete coverage of deepwater well control.

2 References

2.1 STANDARDS

The following standards contain provisions, which through reference in this text, constitute provisions of this standard. All standards are subject to revision and users are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

API	
Spec 6A	<i>Wellhead and Christmas Tree Equipment</i>
RP 5C1	<i>Recommended Practice for Care and Use of Casing and Tubing</i>
RP 5C7	<i>Recommended Practice for Coiled Tubing Operations in Oil and Gas Well Services</i>
RP 7G	<i>Drill Stem Design and Operating Limits</i>
RP 10B	<i>Recommended Practice for Testing Well Cements</i>
RP 13D	<i>Rheology and Hydraulics of Oil-Well Drilling Fluids</i>
RP 13B-1	<i>Standard Procedure for Field Testing Water-based Drilling Fluids</i>