

Isolating Potential Flow Zones During Well Construction

Upstream Segment

API RECOMMENDED PRACTICE 65—PART 2
FIRST EDITION, MAY 2010



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 this 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 these 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, translated, 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, 1220 L Street, NW, Washington, DC 20005.

Copyright © 2010 American Petroleum Institute

Foreword

This document was prepared with input from oil and gas operators, drilling contractors, service companies, consultants and regulators. It is based mainly on experiences in the United States outer continental shelf (OCS) and deepwater operating areas of the Gulf of Mexico, but may be of utility in other offshore and land operating areas. The content of this document is not all inclusive and not intended to alleviate the need for detailed information found in textbooks, manuals, technical papers, or other documents. The formulation, adoption, and publication of API standards are not intended to inhibit anyone from using any other practices.

Shall: As used in a recommended practice, “shall” denotes a minimum requirement in order to conform to the RP.

Should: As used in a recommended practice, “should” denotes a recommendation or that which is advised but not required in order to conform to the RP.

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 standard. 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, 1220 L Street, NW, Washington, DC 20005. 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 by API, 1220 L Street, NW, Washington, DC 20005.

Suggested revisions are invited and should be submitted to the Standards Department, API, 1220 L Street, NW, Washington, DC 20005, standards@api.org.

Contents

Page

1	Scope	1
1.1	Overview	1
1.2	Objectives	1
1.3	Background and Technology Review	1
1.4	Conditions of Applicability	1
1.5	Well Planning and Drilling Plan Considerations	2
1.6	Drilling the Well	2
1.7	Flow Prevention Practices Matrix	2
2	Definitions, and Abbreviated Terms	3
2.1	Definitions	3
2.2	Abbreviations	12
3	Mechanical Barriers	13
3.1	General	13
3.2	Mechanical Barrier	14
3.3	Characteristics and Capabilities	14
3.4	Subsurface Mechanical Barriers	15
3.5	Surface Mechanical Barriers	18
3.6	Alternate Methods	19
3.7	Operational Considerations	20
4	Cementing Practices and Factors Affecting Cementing Success	23
4.1	Introduction	23
4.2	Hole Geometry	23
4.3	Drilling Fluid Type	23
4.4	Casing Hardware	24
4.5	Close-tolerance and Other Flow Restriction Considerations	25
4.6	Engineering Design	26
4.7	Slurry Design and Testing	29
4.8	Wellbore preparation and conditioning	34
4.9	Cement Job Execution	37
4.10	Post Cementing Operations	40
5	Leak Off Tests	42
5.1	Introduction	42
5.2	Pressure Integrity Test Procedures	43
5.3	Pressure Integrity Test Guidelines	44
5.4	LOT Technical References	46
6	Post-Cement Job Analysis and Evaluation	46
6.1	Material Inventory	46
6.2	Job Data	46
6.3	Cement Evaluation	46
6.4	Flow Prevention Practices Matrix	47
Annex A (informative) Background and Technology		48
Annex B (informative) Well Planning and Drilling Plan Considerations		68
Annex C (informative) Drilling the Well		77
Annex D (informative) Cementing Matrix and Instructions		84

Contents

Page

Bibliography	94
---------------------------	-----------

Figures

1 Decision Tree for WOC to ND Surface Stacks	22
A.1 Effect of Curing Pressure on Bond Failure	49
A.2 Annular Pressure and Temperature—Well G	63
A.3 Annular Pressure and Temperature—Well B	64
A.4 Annular Pressure and Temperature—Well A	65
A.5 Mud Densities Measured By Pressure Sensors in Annulus	66
A.6 Summary of the Top 11 Fields Pulsed in Canada	67
B.1 Casing Shoe Depths with Pore Pressure/Fracture Gradient Graph	70

Tables

A.1 Most frequent Primary and Secondary Barriers that Failed in all Phases (Louisiana + Tx + OCS; 1960 to 1996)	53
A.2 Drilling and Service Well Control Occurrences, 1998/1999	54
A.3 Drilling and Service Well Control Occurrences, 2003	54
A.4 Surface Casing Vent Flows	55
A.5 Gas Migration Problems	55
A.6 Packer Isolation Testing and Reporting Program Results	55
A.7 Well Status at Time of the Incident	56
A.8 Blowouts by Well Type	57
A.9 Blowouts by Depth Category	57
A.10 1991 API Survey Data on Lost Circulation	59

Isolating Potential Flow Zones During Well Construction

1 Scope

1.1 Overview

This document contains best practices for zone isolation in wells to prevent annular pressure and/or flow through or past pressure-containment barriers that are installed and verified during well construction. Barriers that seal wellbore and formation pressures or flows may include temporary pressure-containment barriers like hydrostatic head pressure during cement curing and permanent ones such as mechanical seals, shoe formations, and cement. Other well construction (well design, drilling, leak-off tests, etc.) practices that may affect barrier sealing performance are mentioned along with methods to help ensure positive effects or to minimize any negative ones. See Section 2, *Definitions*, for this scope's applicable parameters including types of wells, well barriers, barrier elements, etc.

1.2 Objectives

The objectives of this guideline are two-fold. The first is to help prevent and/or control flows just prior to, during, and after primary cementing operations to install or "set" casing and liner pipe strings in wells. Some of these flows have caused well control incidents that are very serious problems. They threaten the safety of personnel, the environment, and the drilling rigs themselves. The second objective is to help prevent sustained casing pressure (SCP), also a serious industry problem.

Another publication, API 90, provides guidelines on managing annular casing pressure (ACP) including SCP, thermal casing pressure, and operator-imposed pressure. These guidelines include monitoring, diagnostic testing, establishing the maximum allowable wellhead operating pressure (MAWOP), documenting annular casing pressure, and risk assessment methodologies. API 65 has been written to complement the objectives of API 90 and its recommended practices for pressure-containment barriers. Many of the definitions in Section 2 are aligned with those in API 90.

1.3 Background and Technology Review

A detailed background and technology review are in Annex A. Historical data, perspectives, studies, statistics, lessons learned, etc. are included. All this information has been written to help explain how some practices work, have become proven or invalidated, or had performance limitations placed upon their application.

1.4 Conditions of Applicability

The guidance from this document covers recommendations for pressure-containment barrier (cement, packers, etc.) design and installation and well construction practices that affect the zone isolation process to prevent or mitigate annular fluid flow or pressure. Also covered are practices to identify relevant conditions including those predicted in:

- 1) a pre-spud hazard assessment, and
- 2) the actual conditions experienced while the well is being drilled.

These practices may also help prevent loss of well control (LWC) incidents and minimize the occurrence of SCP during well construction and production.

Pre-spud information gathered from offset well(s) and/or from high resolution seismic surveys can be used to define the degree of flow potential (low, medium, high) for a particular drilling prospect. Any relevant information should be communicated to the appropriate service provider for incorporation into the design for a particular fluid (mud or cement) and for preparing engineering and operations procedures.