

API Upstream Standards for Safe Shale Gas Operations – How API Standards can support and contribute for a safe operation – US case

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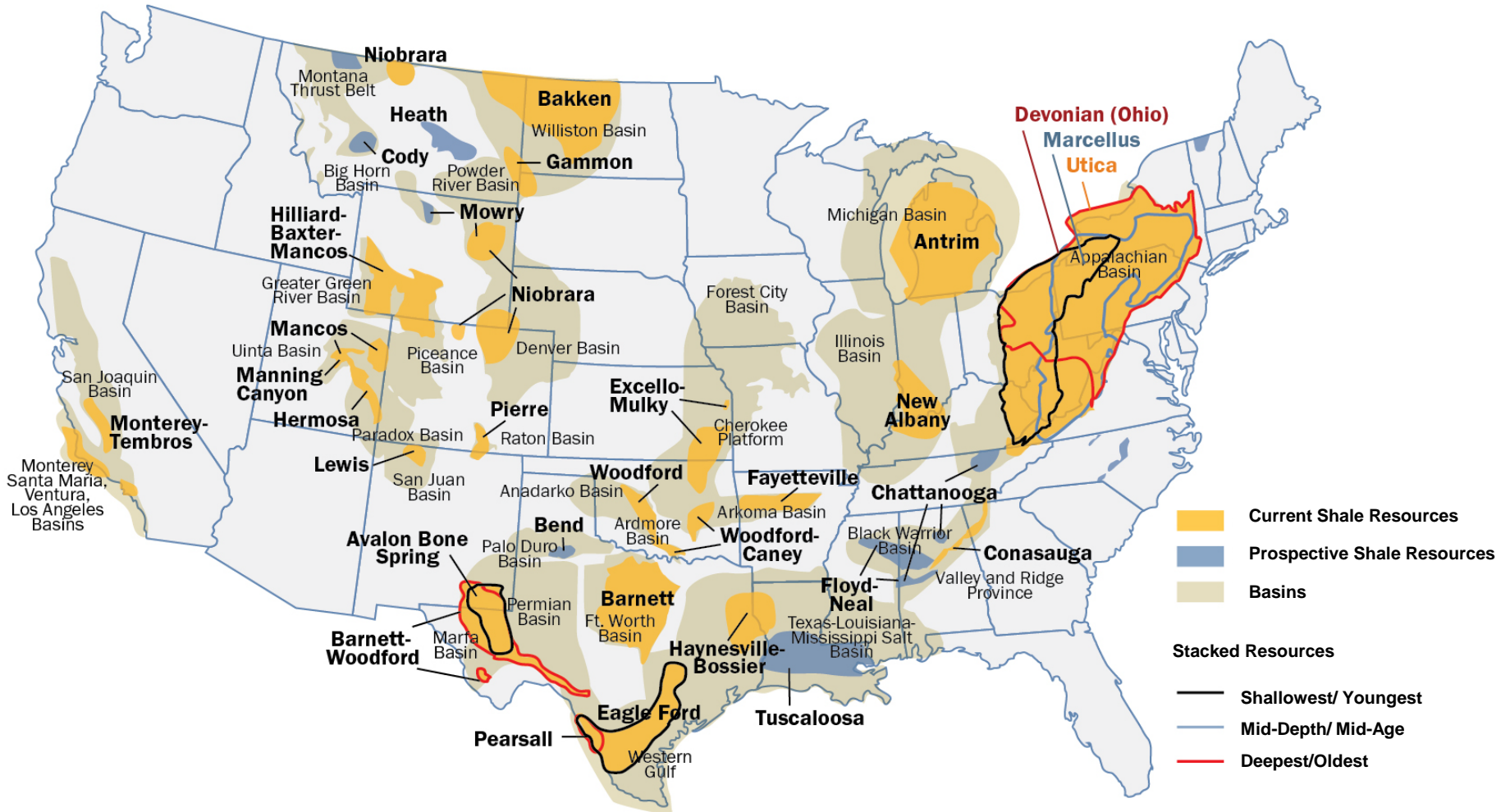
Topics

- ❖ Hydraulic fracturing (HF) and shale gas overview
- ❖ HF basics
- ❖ API standards program and HF-related documents
- ❖ Conclusions

Shale Gas Drilling Technologies

- ❖ **Hydraulic fracturing** is a well completion technology for the development of unconventional resources such as natural gas that is trapped in shale rock formations. It is used to create a fracture network through which oil and gas can migrate to the wellbore.
- ❖ **Horizontal drilling** is a technique where the well is drilled first vertically and then horizontal to surface.

Shale Resources – Lower 48 U.S. States



Current and prospective resources and basins in the continental US

U.S. Shale Gas Resources

- ❖ Prior to 2005, shale gas constituted 4% of U.S. gas production.
- ❖ Shale production is projected to increase from 30% of total U.S. gas production in 2010 to 49% by 2035.
- ❖ Current U.S. domestic production and reserves are now displacing gas and oil imports.

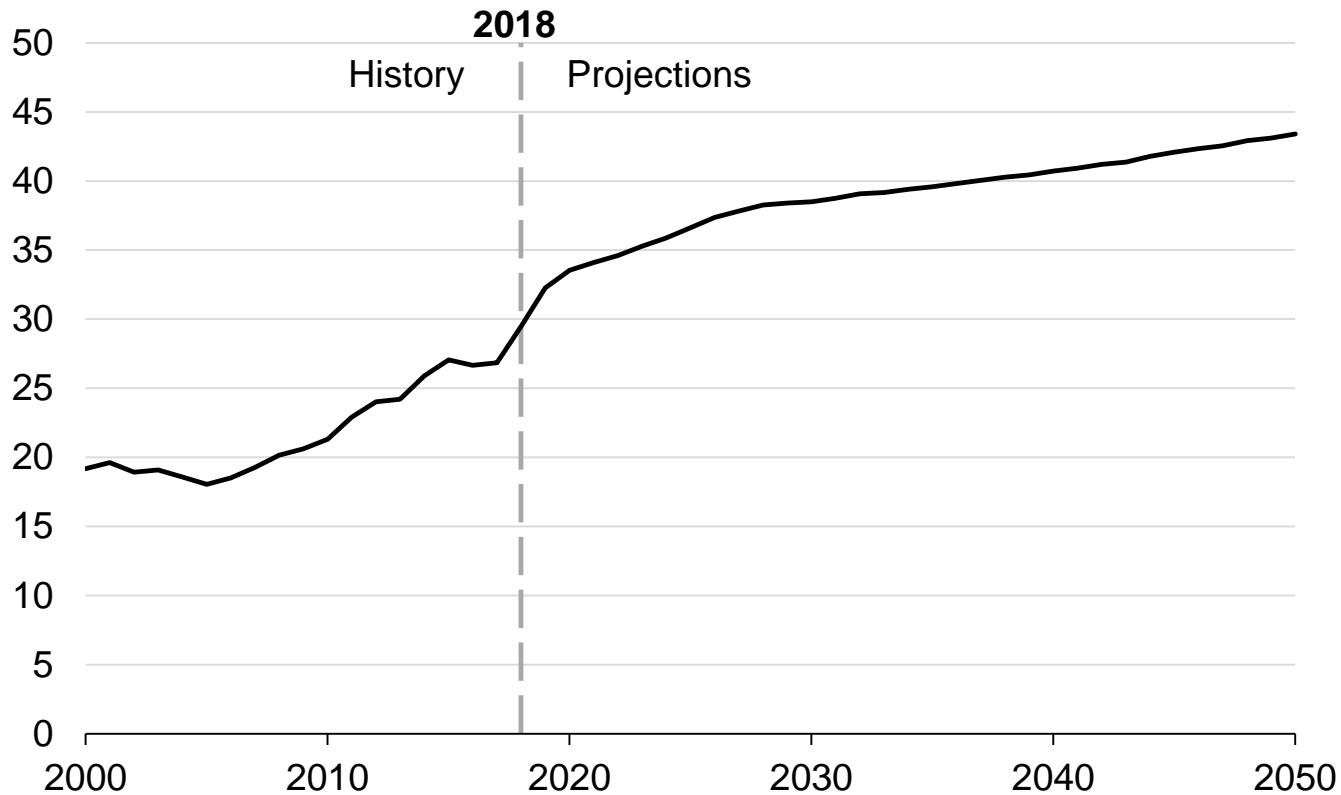
U.S. Petroleum & Natural Gas Production

- ❖ The U.S. has been a net energy importer since 1953 (66 years).
- ❖ Current U.S. domestic production will lead to the U.S. being a net energy exporter in 2020.
- ❖ In 2018, tight oil (shale) development accounted for **50%** of U.S. crude oil production and **68%** of U.S. natural gas production.

U.S. Natural Gas Production

Dry natural gas production
trillion cubic feet

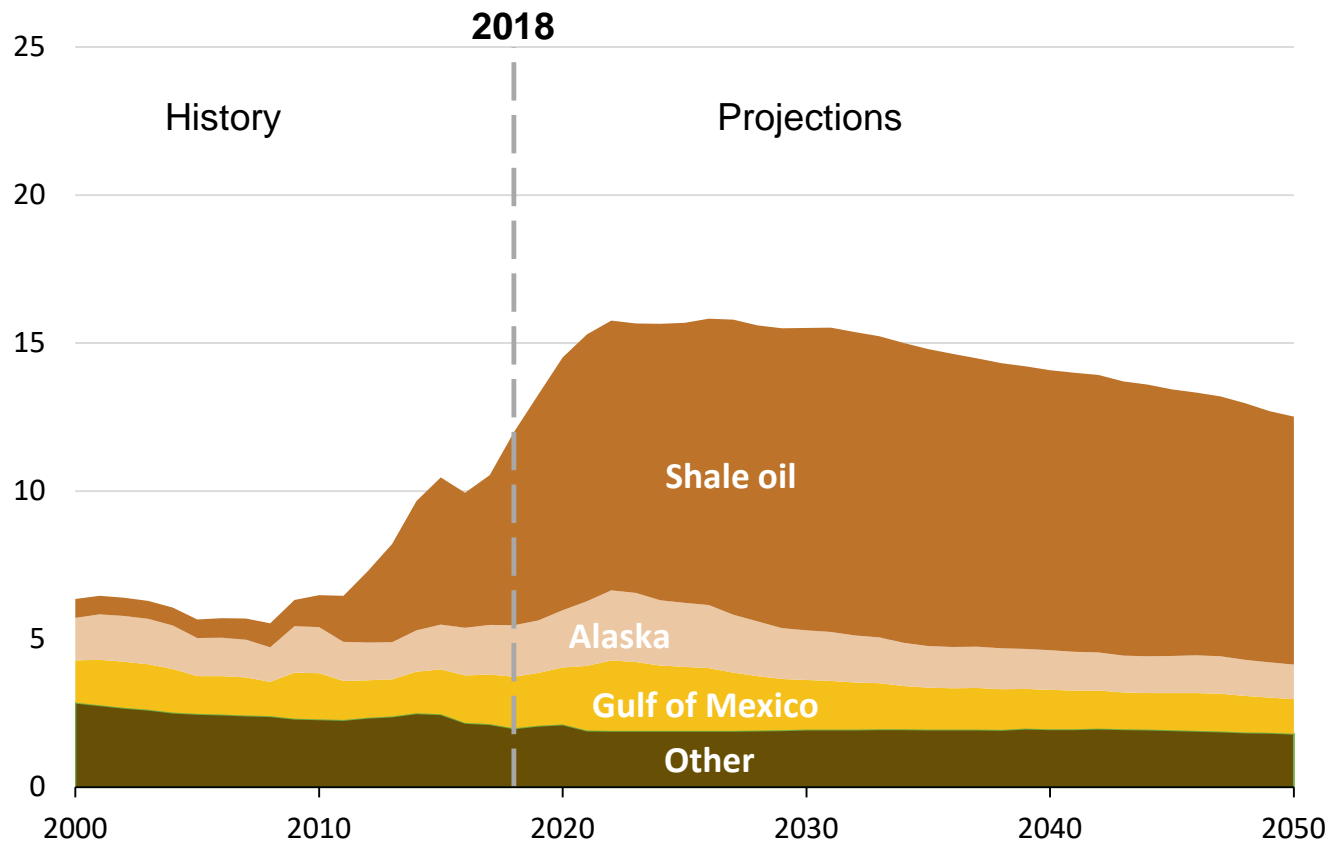
Source: U.S. Energy Information Administration



U.S. Crude Oil Production

million barrels per day

Source: U.S. Energy Information Administration



API Background



About API

- ❖ API is an industry trade association representing all segments of the oil and natural gas industry.
- ❖ Over 660 member companies involved in all aspects of the oil and natural gas industry.
- ❖ Over 700 committees and task forces covering various advocacy and technical issues.
- ❖ Staff of ~275 located in Washington, DC and in 34 states.
- ❖ International offices in Brazil, China, Singapore, and the UAE.

About API

- ❖ API is accredited by the American National Standards Institute (ANSI) and must comply with the following:
 - openness, balance, consensus, due process;
 - standards undergo regular review (5 years minimum);
 - regular program audits (conducted by ANSI);
 - transparent process (anyone can comment on any document).

- ❖ All comments **must** be considered.

- ❖ API corporate membership is **not required**.

Value of API Standards

- ❖ Improves safety and reliability.
- ❖ Improves equipment interchangeability.
- ❖ Reduces compliance costs.
- ❖ Reduces procurement costs.
- ❖ Foundation for company standards.

Use of API Standards

- ❖ **National Technology Transfer and Advancement Act (NTTAA):**
 - NTTAA requires Federal Agencies to use voluntary consensus standards, encourages participation;
 - API standards are cited in regulations by U.S. regulatory agencies including BSEE, DOT, EPA, OSHA, SEC, and USCG;
 - 130 API standards are cited 460 times in U.S. Federal Regulations.

- ❖ **API Standards also widely cited by States:**
 - 216 API standards are cited 4035 times in U.S. State Regulations.

Shale Gas/HF-related Standards

Hydraulic Fracturing—Well Integrity and Fracture Containment

ANSI/API RECOMMENDED PRACTICE 100-1
FIRST EDITION, OCTOBER 2015

Isolating Potential Flow Zones During Well Construction

API STANDARD 65—PART 2
SECOND EDITION, DECEMBER 2010

REAFFIRMED, NOVEMBER 2016

Managing Environmental Aspects Associated with Exploration and Production Operations Including Hydraulic Fracturing

ANSI/API RECOMMENDED PRACTICE 100-2
FIRST EDITION, AUGUST 2015

Community Engagement Guidelines

ANSI/API BULLETIN 100.3
FIRST EDITION, JULY 2014

Environmental Protection for Onshore Oil and Gas Production Operations and Leases

API RECOMMENDED PRACTICE 51R
FIRST EDITION, JULY 2009

REAFFIRMED, DECEMBER 2015

API RP 100-1

**Hydraulic Fracturing—Well Integrity
and Fracture Containment**

ANSI/API RECOMMENDED PRACTICE 100-1
FIRST EDITION, OCTOBER 2015

- ❖ **Scope** – contains recommended practices for onshore well construction and fracture stimulation design and execution as it relates to well integrity and fracture containment.
- ❖ The goals are to design a well plan that isolates and protects groundwater from drilling and fracturing operations and use well equipment that can meet the expected fracture load requirements.

API RP 100-1

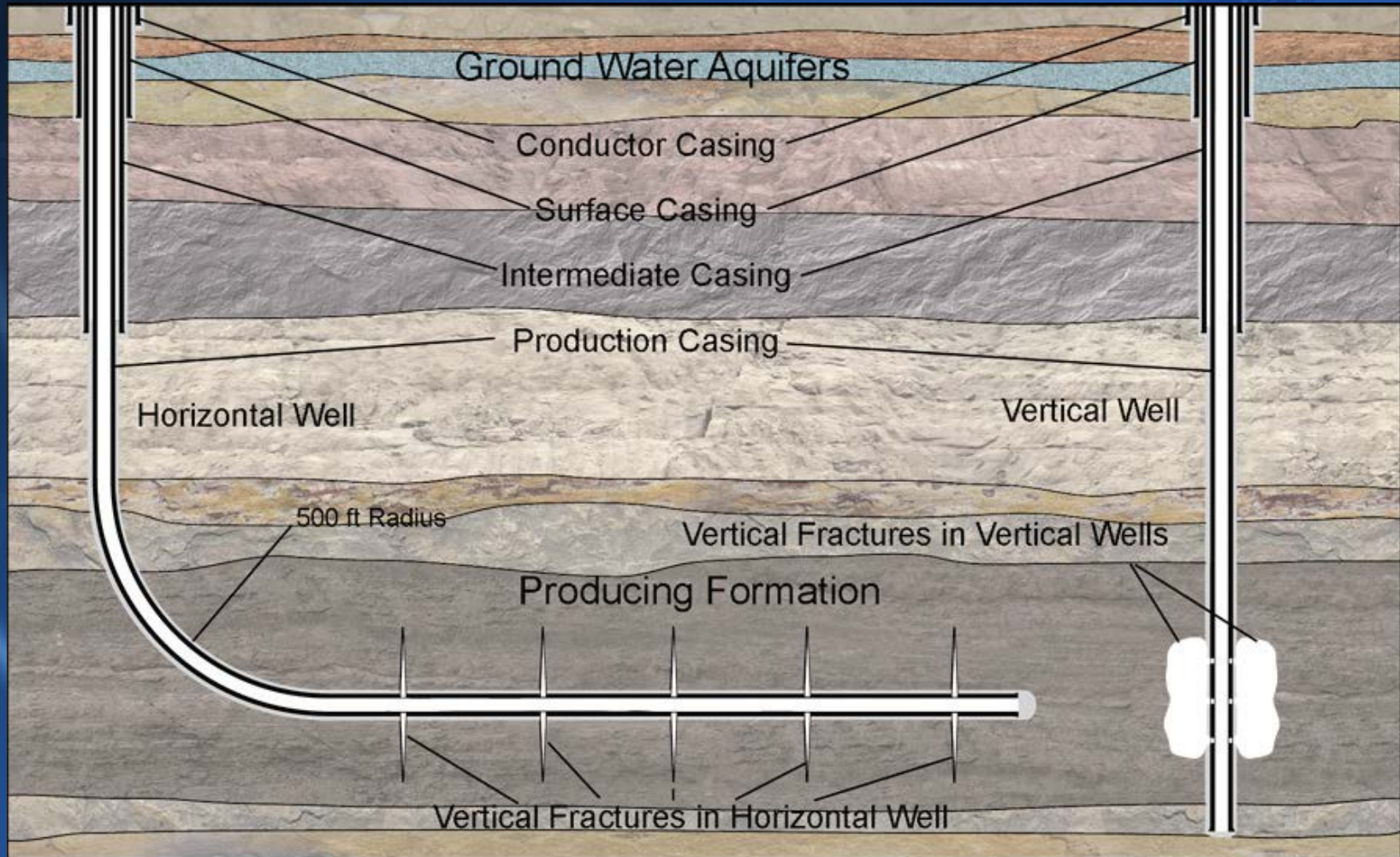
- ❖ **Well integrity:** the design and installation of well equipment to a standard that
 - protects and isolates useable quality groundwater,
 - delivers and executes a hydraulic fracture treatment, and
 - contains and isolates the produced fluids.

- ❖ **Fracture containment:** the design and execution of hydraulic fracturing treatments to contain the resulting fracture within a prescribed geologic interval encompassing
 - existing formation parameters and their associated range of uncertainties,
 - well barriers and integrity created during well construction, and
 - controllable fracture design and execution parameters.

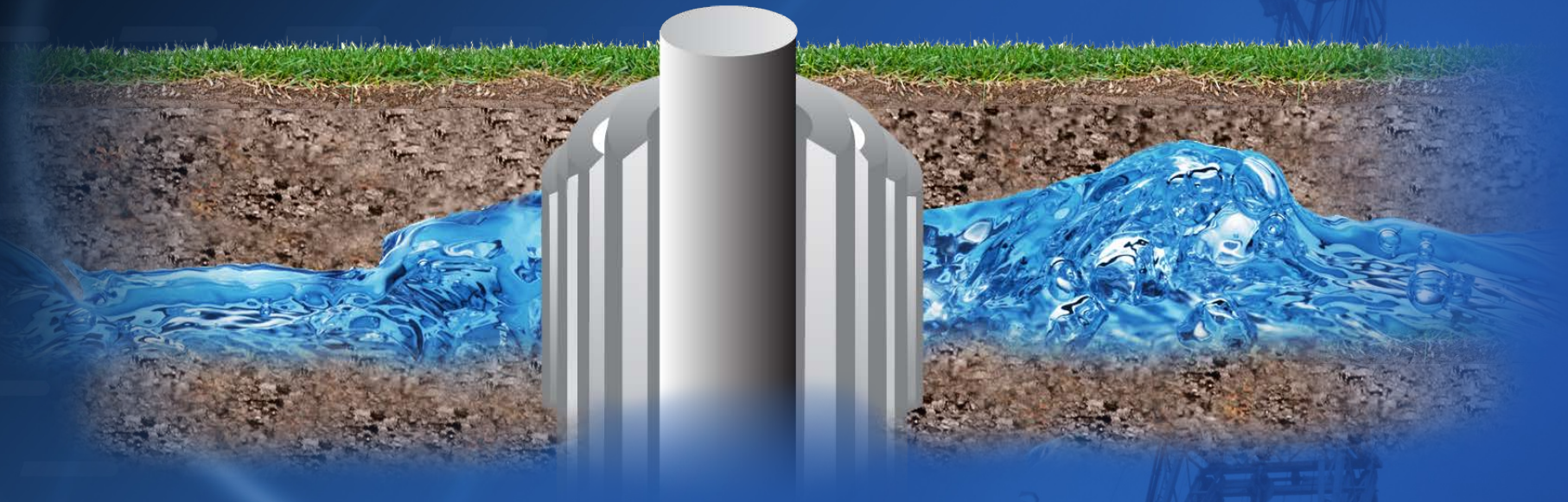
API RP 100-1

- ❖ This document is not a detailed well construction or fracture design manual.
- ❖ While industry-wide practices concerning well construction are similar, there are considerable variations in the details of individual well design and construction due to varying geologic, environmental, regulatory, and operation requirements.
- ❖ Proven practices are the result of operators gaining localized and specific knowledge based on experience, along with the development and improvements associated with technology.

Well Production Casing



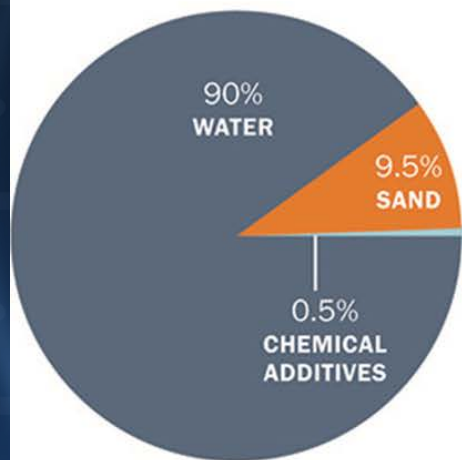
Each well contains multiple layers of casing and cementing to protect groundwater



Well design and construction has four main components.

1. Conductor casing (isolate shallow groundwater and surface sediments).
2. Surface casing (isolate groundwater aquifers).
3. Intermediate casing (isolate subsurface formations, protect from pressure).
4. Production casing (isolate production zone).

Understanding Fracturing Fluids



Compound	Purpose	Common application
Acids	Helps dissolve minerals and initiate fissure in rock (pre-fracture)	Swimming pool cleaner
Sodium Chloride	Allows a delayed breakdown of the gel polymer chains	Table salt
Polyacrylamide	Minimizes the friction between fluid and pipe	Water treatment, soil conditioner
Ethylene Glycol	Prevents scale deposits in the pipe	Automotive anti-freeze, deicing agent, household cleaners
Borate Salts	Maintains fluid viscosity as temperature increases	Laundry detergent, hand soap, cosmetics
Sodium/Potassium Carbonate	Maintains effectiveness of other components, such as crosslinkers	Washing soda, detergent, soap, water softener, glass, ceramics
Glutaraldehyde	Eliminates bacteria in the water	Disinfectant, sterilization of medical and dental equipment
Guar Gum	Thickens the water to suspend the sand	Thickener in cosmetics, baked goods, ice cream, toothpaste, sauces
Citric Acid	Prevents precipitation of metal oxides	Food additive; food and beverages; lemon juice
Isopropanol	Used to increase the viscosity of the fracture fluid	Glass cleaner, antiperspirant, hair coloring



API RP 100-2

**Managing Environmental Aspects
Associated with Exploration and
Production Operations Including
Hydraulic Fracturing**

ANSI/API RECOMMENDED PRACTICE 100-2
FIRST EDITION, AUGUST 2015

- ❖ **Scope** – provides proven practices applicable to the planning and operation of wells, and hydraulically fractured wells.
- ❖ Topics covered include recommendations for managing environmental aspects during planning, site selection, logistics, mobilization, rig-up, and demobilization, and stimulation operations.
- ❖ Includes guidance on managing environmental aspects during well construction.

API RP 100-2

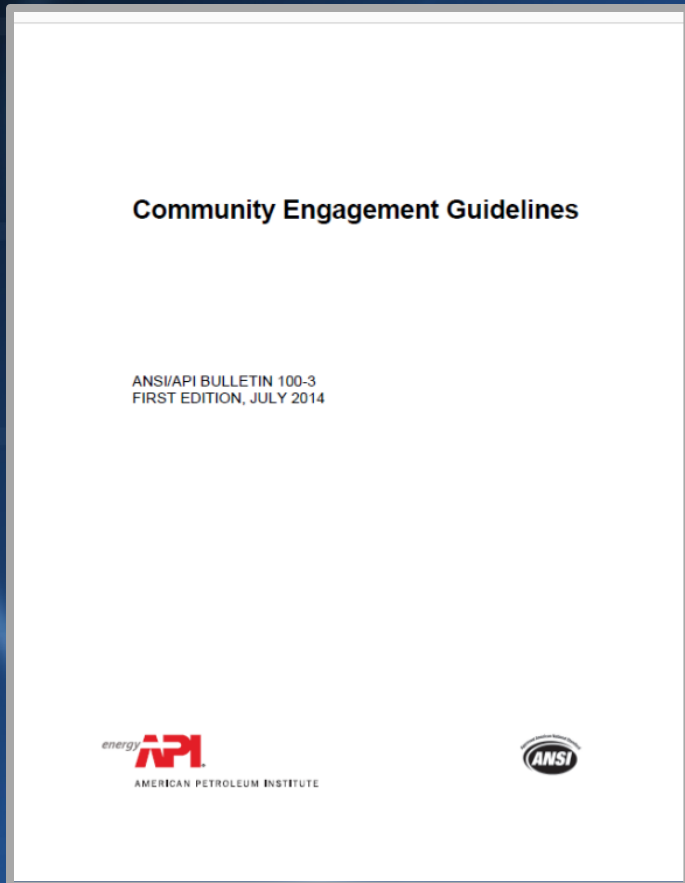
❖ Provides recommendations on the following topics:

- baseline groundwater sampling
- source water management
- material selection
- transportation of materials and equipment
- storage and management of fluids and chemicals
- management of solid and liquid wastes
- air emissions
- site planning
- training
- noise and visual resources

API RP 100-2

- ❖ Puts hydraulic fracturing into perspective relative to drilling, completions, and production lifecycle
- ❖ Most aspects are independent of the well stimulation practice used to improve production
- ❖ Describe baseline practices
- ❖ Establish consistent terminology
- ❖ Recommended practices are site-specific and can vary over the lifecycle of the well

API Bulletin 100-3



- ❖ **Scope** – outlines what local communities and other key stakeholders can expect from operators.
- ❖ Designed to **acknowledge challenges and impacts** that occur during the industry’s presence in a given region.
- ❖ Provides **flexible and adaptable** strategies, recognizing application will vary from operator to operator and community to community.
- ❖ Guidelines are intended to support onshore oil and gas projects for shale developments; however, are adaptable to any oil and gas project.

API Bulletin 100-3

- ❖ **Share as a guide for “good neighbor” policies to help maintain a license to operate.**
- ❖ **Manage expectations for all stakeholders.**
- ❖ **To be used by stakeholders and industry—operators, contractors, service companies, and local communities and officials.**
- ❖ **Assist the operator in developing an adaptable and evergreen engagement plan.**
- ❖ **Build long-lasting, successful relationships within the communities where the industry operates.**

API Bulletin 100-3 Guiding Principles

- ❖ **Integrity** – “Companies operating with integrity strive to build positive and constructive relationships within the community and accumulate long-term sustainable relationships.”
- ❖ **Safety & Environmental Responsibility** – “Operate daily in a manner that protects the safety, environment and health of communities, employees and contractors during the complete lifecycle of the project.”
- ❖ **Communicating Effectively** – “Communication is a two-way process of giving and receiving information through a number of channels.... following basic communication principles to build credibility and improve dialogue and understanding.”

Timeline of a Well

EXPLORATION

3–5 years



PLANNING

12–18 months



SITE & WELL CONSTRUCTION

2–3 months



HYDRAULIC FRACTURING

3–5 days



PRODUCTION

30 + Years



API RP 51R

- ❖ Provides environmentally sound guidance for domestic onshore oil and gas operations.
- ❖ Includes all production facilities and waste water handling facilities.
- ❖ Coverage begins with design and construction of access roads and includes reclamation, abandonment and restoration operations.

**Environmental Protection for
Onshore Oil and Gas Production
Operations and Leases**

API RECOMMENDED PRACTICE 51R
FIRST EDITION, JULY 2009

REAFFIRMED, DECEMBER 2015

API RP 51R

- ❖ **Key areas of coverage are**
 - **roads;**
 - **Production and injection/disposal wells;**
 - **gathering and system lines;**
 - **production and water handling facilities.**

- ❖ **Includes guidance on**
 - **Protection of the environment;**
 - **personnel selection, training, and qualification;**
 - **protection of public safety;**
 - **respect for property owner rights.**

API Std 65-2

- ❖ **Scope** – contains practices for isolating potential flow zones, an integral element in maintaining well integrity.
- ❖ The focus of this standard is the prevention of flow through or past barriers that are installed during well construction.

Isolating Potential Flow Zones During Well Construction

API STANDARD 65—PART 2
SECOND EDITION, DECEMBER 2010

REAFFIRMED, NOVEMBER 2016

API Std 65-2

- ❖ Describes industry recommended cementing and well construction techniques to help ensure proper cementing to include:
 - planning;
 - design;
 - testing;
 - execution;
 - post-cement job analysis and process summary.

- ❖ Defines different types of mechanical barriers, including cement as a barrier.

- ❖ Addresses cementing practices and factors that lead to a successful cementing job.

Additional API Upstream Safety Standards

- ❖ *Spec 14A – Subsurface Safety Valve Equipment*
- ❖ *RP 14B – Design, Installation, Operation, Test, and Redress of Subsurface Safety Valve Systems*
- ❖ *RP 14C – Analysis, Design, Installation, and Testing of Safety Systems for Offshore Production Facilities*
- ❖ *RP 14G – Fire Prevention and Control on Fixed Open-Type Offshore Production Platforms*
- ❖ *RP 14J – Design and Hazards Analysis for Offshore Production Facilities*
- ❖ *Spec 16A – Drill-through Equipment*
- ❖ *Std 16AR – Repair and Remanufacture of Drill-Through Equipment*
- ❖ *Spec 16C – Choke and Kill Equipment*
- ❖ *Spec 16D – Control Systems for Drilling Well Control Equipment and Control Systems for Diverter Equipment*

Additional API Upstream Safety Standards

- ❖ *Std 18LCM – Product Life Cycle Management System Requirements for the Petroleum and Natural Gas Industries*
- ❖ *RP 49 – Drilling and Well Servicing Operations Involving Hydrogen Sulfide*
- ❖ *Std 53 – Blowout Prevention Equipment Systems for Drilling Wells*
- ❖ *RP 54 – Occupational Safety for Oil and Gas Well Drilling and Servicing Operations*
- ❖ *RP 55 – Oil and Gas Producing and Gas Processing Plant Operations Involving Hydrogen Sulfide*
- ❖ *RP 59 – Well Control Operations*
- ❖ *RP 64 – Diverter Equipment Systems*
- ❖ *RP 67 – Oilfield Explosives Safety*
- ❖ *RP 74 – Occupational Safety for Onshore Oil and Gas Production Operation*
- ❖ *RP 75 – Development of a Safety and Environmental Management Program for Offshore Operations and Facilities*

Additional API Upstream Safety Standards

- ❖ *Bull 75L – Development of a Safety and Environmental Management System for Onshore Oil and Natural Gas Production Operation and Associated Activities*
- ❖ *RP 76 – Contractor Safety Management for Oil and Gas Drilling and Production Operations*
- ❖ *RP 90 – Annular Casing Pressure Management for Offshore Wells*
- ❖ *RP 90-2 – Annular Casing Pressure Management for Onshore Wells*
- ❖ *RP 96 – Deepwater Well Design and Construction*
- ❖ *Bull 97 – Well Construction Interface Document Guidelines*
- ❖ *RP 98 – Personal Protective Equipment Selection for Oil Spill Responders*
- ❖ *RP 99, Flash Fire Risk Assessment for the Upstream Oil and Gas Industry*
- ❖ *Bull E2 – Management of Naturally Occurring Radioactive Materials (NORM) in Oil and Gas Production*

Conclusions

- ❖ **The shale gas revolution is a true game-changer; U.S. crude oil and natural gas production continues to grow as a result of the further development of tight oil resources.**
- ❖ **The U.S. will become a net energy exporter in 2020 and will remain so through 2050 as a result of large increases in production of crude oil and natural gas, and increasing energy efficiency.**
- ❖ **API standards represent industry's collective wisdom on operational practices, developed and refined over many years, and are an integral part of API's hydraulic fracturing program.**

Questions?

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