

Well Integrity Regulatory Elements for Consideration

Prepared by
The Ground Water Protection Council

January 2021



Introduction

These “Regulatory Elements for Well Integrity” are intended to provide regulators with a set of ideas to consider when improving oversight of the permitting, construction, operation and plugging of oil and gas wells. The Elements were developed by a group of state officials who met informally in conjunction with GWPC meetings in Nashville, Tennessee (September 23 – 26, 2012), Sarasota, Florida (January 22 – 24, 2012), and St. Louis (September 22 – 25, 2013). The elements were updated by a small group of state officials in July, 2020

The state officials based these Elements on a draft prepared by Scott Kell, Deputy Chief of the Ohio Department of Natural Resources Division of Oil and Gas, that summarized topics addressed by the Model Regulatory Framework for Well Integrity for Hydraulically Fractured Hydrocarbon Production Wells published by Environmental Defense Fund and Southwestern Energy (www.edf.org/mrf) (the MRF). The MRF, which is written in the detailed language of regulation, has been used by several states when updating their rules. In contrast, these Elements are a topical outline of subjects that regulators may find useful when updating rules and policies.

Like the MRF, these Elements are intended to apply primarily to onshore hydrocarbon production wells (other than coalbed methane wells) that are hydraulically fractured. However, many of these topics may also be worthy of consideration when addressing other types of oil and gas wells, such as natural gas storage wells.



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Well Integrity Regulatory Elements for Consideration

I. Well Planning – Regulator Approvals

- A. Regulator approves plans for proposed wells consistent with objectives; e.g.:
 - 1. Prevent contamination of protected water, and hydrocarbon-bearing zones through effective well construction and zonal isolation practices.
 - 2. Protect human health, safety, and the environment.
 - 3. Approvals occur prior to commencement of activities.
- B. Plan Elements
 - 1. Well Spacing
 - a) Operator identifies zones that may be tested and stimulated by hydraulic fracturing.
 - b) Operator identifies the proposed location of the well relative to unit boundaries.
 - c) Operator identifies and/or regulator evaluates the distance to offset wells that penetrate the target producing zone or affected strata within the “area of investigation,” to determine if proximal wellbores are potential conduits for out-of-zone migration of stimulation fluids, and to implement corrective action when necessary.
 - d) Operator attests, and/or regulator affirms, that there are no known pathways (natural or wellbore) to convey stimulation fluids or gas from “affected strata” into protected groundwater based upon an assessment of the area of investigation.
 - e) Establish standards for conducting wellbore deviation and inclination surveys.
 - 2. Wellbore Construction
 - a) Operator provides, and/or regulator approves, a casing and cementing plan that demonstrates how protected groundwater and potentially productive zones will be effectively isolated.
 - b) Operator provides and/or regulator approves a casing and cementing plan that addresses how anticipated hazards such as mines or voids will be addressed.
 - 3. Well Stimulation
 - a) Operator provides information about the hydraulic fracturing plan specified (e.g., anticipated treatment pressure estimation or calculation of anticipated fracture length and height).
 - b) Operator provides information regarding anticipated base fluid including anticipated volume of water, if applicable.
 - c) Operator attests, or regulator affirms, that adequate confining layer(s) exist to prevent migration of pumped stimulation fluids or gas into a source of protected water.
- C. Regulator Authority/Responsibilities
 - 1. Regulator identifies aquifers that must be protected or establishes criteria for

- identifying protected groundwater.
2. Regulator maintains data and provides information to the industry regarding the depth or basal elevation of protected groundwater, and wellbore depths and locations.
 3. Regulator determines or approves the depth of the deepest protected groundwater.
 4. Regulator may require sampling and testing, or logging to determine the deepest protected aquifer in areas where it is unknown.
 5. Regulator maintains a public database that depicts the proposed surface location, kick-off point, landing point and bottomhole locations for all proposed wells.
 6. Regulator defines and establishes more stringent standards for wells that may be stimulated by hydraulic fracturing when there are questions about the adequacy of confining layer(s).

II. Well Control

A. Performance Objectives

1. Maintain well control (prevent blowouts) during all phases of drilling, testing, completion, workover and plugging operations to prevent contamination of protected water and protect human health, safety, and the environment.

B. Elements

1. Establishes requirements for blowout preventers, control heads and accumulators capable of controlling the maximum anticipated pressure that may be encountered during drilling operations.
2. Establishes testing procedures to evaluate the ongoing functionality of well control equipment.
3. If drilling with a mud system, establishes standards for fluid properties necessary to maintain well control.
4. Establishes requirements for continual or regular monitoring of the fluid system.
5. Establishes requirement for a rotating control head if drilling on air, or a diverter system for other defined circumstances (e.g., drilling surface borehole in new exploratory areas).
6. Establishes testing procedures to verify the ongoing functionality of the diverter system and associated lines.
7. Defines when inspectors must be notified prior to well control equipment tests.
8. Establishes requirements for Formation Integrity Tests where necessary to assess breakdown pressure of strata beneath the surface and intermediate casing seats.
9. Establishes standards for equipment used to control pressures during completion operations.
10. Establishes standards for wellhead assemblies.
11. Establishes requirements for operator to perform anti-collision evaluation of offset wellbores prior to drilling operations.
12. Establishes requirements for simultaneous operations during the drilling, construction, and operational phases on well pads.
13. Establishes requirements and thresholds for operator to report well control pressures and fluid changes that exceed normal operating conditions (e.g., influx of formation fluids and increase in fluid return rate).

14. Establishes standards for emergency response planning.

III. Drilling-Well Construction

A. Performance objectives; e.g.:

1. Isolate protected groundwater zones.
2. Support effective well control.
3. Isolate corrosive zones.
4. Isolate flow zones capable of over-pressurizing the surface casing annulus or adversely affecting the cement job.
5. Isolate potentially productive zones including the target producing zone.
6. Isolate other protected mineral resources, if applicable.
7. Address lost circulation zones and drilling hazards such as mine or solution voids, if applicable.

B. Regulations are sufficiently flexible to address variable conditions

1. Authority to establish field rules, and/or;
2. Authority to issue permits subject to well-specific conditions; and/or;
3. Authorizes site-specific modification of approved plans to address actual wellbore conditions based upon site conditions.

C. Drilling Fluids

1. Establishes types of fluids and additives that may be used while drilling through protected groundwater in an uncased wellbore.

D. Appropriate casing and casing equipment quality standards

1. Establishes criteria for casing quality (new and/or reconditioned) based on well depth and other anticipated completion factors, including an appropriate safety factor.
2. Establishes criteria for standard casing tests according to specified or referenced methods.
3. Establishes or references quality standards for centralizers.

E. Appropriate cement quality standards

1. Establishes or references standard methods for manufacture of cements.
2. Establishes or references testing standards for consideration of cement slurries for which published data is unavailable, prior to cementing.
3. Establishes or references standards for cement testing to be performed on a periodic basis or when there is a change in operating condition, cement type, or cement vendor.
4. Establishes standards for mix water quality.
5. Establishes authority to require specific blends to isolate problematic zones (such as corrosive H₂S-bearing zones).
6. Establishes or references standards for cement slurries circulated to effectively isolate natural gas flow zones.

F. Wellbore circulation and conditioning

1. Establishes standards for proper conditioning of the wellbore prior to cement emplacement.
2. Establishes standards for wellbore circulation prior to commencement of cementing, if

technically feasible.

G. Cement placement and job evaluation

1. Establishes allowable methods for effective cement placement.
2. Establishes standards for mixing and pumping cement slurry (e.g., free water separation and optimum density standards).
3. Establishes requirements for minimum annular space, between wellbore and casing or casing and casing, to ensure emplacement of an effective cement sheath that can be verified by test or log.
4. Establishes or references standards for casing make-up.
5. Establishes casing running practices to maintain well control and wellbore integrity for cementing.
6. Establishes standards for centralization of casing.
7. Specifies when an operator is required to notify an inspector prior to installing casing and/or commencement of cementing operations.
8. Establishes conditions under which further assessment and corrective action may be necessary (e.g., circulation problems or other indicators of deficient or defective cement).
9. Establishes process for regulatory approval of a plan for corrective action if there are indications of deficient or defective cement.
10. Specifies when cement evaluation logs or other diagnostic tests should be performed.
11. Specifies notifications and actions when tests demonstrate that performance objectives are not satisfied.
12. Establishes minimum compressive strength standard for zone of critical cement prior to continuing downhole operations.
13. Establishes operator oversight/responsibility standard.

H. Contractor/Service Company Licensing or Approvals

1. Establishes authority to require use of approved cement contractors and service companies.
2. Establishes criteria for approval of cement contractors and service companies.

I. Construction standards address performance objectives (By string)

1. Conductor Casing
 - a) Establishes standards for installation and cementing of conductor pipe, where necessary to protect human health, safety, and the environment.
2. Surface Casing
 - a) Establishes minimum depth for casing below the base of protected water adjacent to a competent formation.
 - b) Establishes maximum depth for surface casing (e.g., surface casing must be set before the borehole penetrates hydrocarbon-bearing zones, flow zones or other lesser-quality water bearing aquifers).
 - c) Requires circulation of cement to surface.
 - d) Establishes when diagnostic tests and corrective action are required if cement does not circulate, or there are other indicators of deficient or defective cementing.
 - e) Establishes initial surface casing pressure testing prior to complete drillout of the plug.
 - f) Establishes additional surface casing pressure testing based on drill time on

subsequent casing string.

- g) Establishes standards for casing centralization.
- 3. Intermediate Casing
 - a) Establishes circumstances where intermediate casing is required (e.g., when necessary to address hazards, isolate hydrocarbon-bearing flow zones, ensure well control when drilling into higher pressure zones, loss circulation zones, or conserve and protect natural resources).
 - b) Establishes a minimum standard for the height of cement above the zones that are to be isolated.
 - c) Establishes when diagnostic tests and corrective action are required.
 - d) Establishes standards for casing centralization.
- 4. Production Casing
 - a) Zones above the target producing zone, must be isolated if necessary, to prevent annular over-pressurization (if not isolated using intermediate casing).
 - b) Establishes a minimum standard for the height of cement above the uppermost perforation of the production casing or top of the production zone, or uppermost zone requiring isolation (flow zone, corrosive zone hydrocarbon-bearing zones and other hazard).
 - c) Establishes additional standards for wells with a limited intervening zone.
 - d) Establishes when diagnostic tests and corrective action are required.
 - e) Establishes standards for casing centralization.

J. Assessment of mechanical integrity after each casing string is emplaced and cemented

- 1. Establishes requirements for reporting of defective casing or cement diagnostic work and appropriate corrective action.
- 2. Establishes standard for pressure test prior to drill-out to verify casing integrity and cement displacement.
- 3. Defines when cement evaluation logs or other approved methods are required to assess integrity.

K. Reports

- 1. Regulator maintains a public database that depicts the actual surface location, kick-off point, landing point and bottomhole locations for wells.
- 2. Establishes deadline, certification process, and confidentiality provisions for required records.
- 3. Establishes report types and minimum data elements for wellbore construction reports (e.g., cement tickets, directional or inclination surveys, cement evaluation logs, casing and casing equipment reports).
- 4. Establishes log and reporting requirements for geologic information (e.g., mud log records, wireline logs and well completion reports) including base of protected water zones, depth and thickness of hydrocarbon-bearing flow zones, lost circulation zones, formation voids, the intervening zone and all zones to be tested or produced.
- 5. Addresses industry and state record retention requirements.

IV. Well Completion-Hydraulic Fracturing

A. Performance Objectives, e.g.:

1. Protected water is not contaminated by fluids pumped during stimulations operations or surface releases of produced water during flowback or swabbing operations.
2. Pumped fluids are directed into the permitted target producing zone and effectively confined, by strata in the overlying intervening zone.
3. Wellbore integrity is monitored and maintained throughout the stimulation operation.
4. Integrity failures are addressed, and corrective actions affirmed by test prior to commencement of hydraulic fracturing operations.

B. Pre-Stimulation Testing & Notification

1. Specifies when an operator is required to notify regulator prior to commencement of testing and stimulation.
2. Establishes standard for wellbore mechanical integrity verification before commencement of hydraulic fracturing operations.
3. Establishes standard for surface equipment integrity verification before commencement of hydraulic fracturing operations.
4. Establishes requirements for notification of offset operators regarding commencement of fracture stimulation.

C. Hydraulic Fracturing Operations

1. Specifies which casing strings may be perforated for stimulation purposes.
2. Establishes criteria for continuous monitoring of wellbore integrity in the well being fracture stimulated and in offset wells throughout the hydraulic fracturing operation.
3. Identifies injection parameters that should be continuously monitored and recorded during the hydraulic fracturing operation.
4. Establishes criteria for terminating hydraulic fracturing operations if there is evidence of mechanical integrity failure or if geologic barriers are not containing fracture pressure or fluids as expected.
5. Establishes conditions for notifying regulator if failure symptoms are observed in the well being fracture stimulated and/or offset wells affected by the hydraulic fracturing operations.

D. Reports

1. Establishes deadlines, certification processes and confidentiality provisions for required records.
2. Establishes report types and minimum data elements for wellbore construction reports (e.g., perforation reports, pumping charts, job summary reports, well completion reports, etc.).
3. Addresses record retention requirements for industry and state-maintained records.

E. Hydraulic Fracturing Service Company Licensing or Approvals

1. Establishes authority to require use of approved service companies.
2. Establishes criteria for approval of hydraulic fracturing service companies.

V. Production Operations

A. Objectives, e.g.:

1. Prevent contamination of protected water.
2. Maintain wellbore integrity.

3. Protect human health, safety, and the environment.

B. Elements

1. Establishes standard for monitoring of wellbore integrity during the production phase of E&P operations (e.g. Post-completion tubing, casing, and bradenhead pressures are monitored to detect Mechanical Integrity (M.I.) failures and potential annular over-pressurization).
2. Identifies when operator must notify Regulator if M.I. failures and/or annular over-pressurization are detected.
3. Process defined to prevent annular over-pressurization.
4. Establishes wellhead equipment and well pad inspection standards.

C. Reports

1. Rules establish reporting obligations and time frames for all produced fluids.

VI. Well Plugging

A. Objectives, e.g.:

1. Hydrocarbon-bearing zones are effectively confined using approved plugging materials that are emplaced in accordance with approved methods.
2. The protected groundwater aquifers are sealed using approved plugging materials that are emplaced in accordance with approved methods.
3. Other natural resources (e.g., coal, halite or trona) are isolated and protected.

B. Elements

1. Notifications/Approvals
 - a) Defines process for approval of a plugging plan prior to commencement of plugging operations.
 - b) Allows plugging operations to commence only after plan approval.
2. Time frames
 - a) Establishes time frames for plugging dry holes.
 - b) Establishes time frames for plugging inactive wells.
 - c) Establishes process for extensions and suspension of extensions.
3. Temporary inactive (suspended) status
 - a) Establishes requirements for acquiring Temporary Inactive status.
 - b) Establishes the term for Temporary Inactive status.
 - c) Establishes process for extensions and revocation of extensions.
4. Plugging operations
 - a) Defines zones that require isolation.
 - b) Establishes cement quality standards.
 - c) Establishes appropriate standards for slurry preparation and placement.
 - d) Establishes standards for mix water quality.
 - e) Establishes standards for conditioning of the wellbore and requirements for maintaining static wellbore conditions prior to plug placement.
 - f) Specifies the thickness and spacing of required plugs.
 - g) Specifies when and how plugs must be tagged or tested.

- h) Establishes standards for permanent marking or accurate measurement of the location of a properly plugged well.
- 5. Inspections and Oversight
 - a) Establishes regulator notification requirements.
 - b) Establishes criteria for regulator approval or corrective action order.
- 6. Flexibility
 - a) Allows approval and use of alternative materials and methods that are consistent with performance objectives.
 - b) Establishes plug placement criteria that are tailored to varying well configuration and construction types.
- 7. Reports
 - a) Establishes deadlines and certification processes for plugging reports.
 - b) Establishes minimum data elements for plugging reports.