

# **Well Integrity Regulatory Elements for Consideration**

Prepared by the Ground Water Protection Council  
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# 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 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](http://www.edf.org/mrf)) (the MRF). The MRF, which is written in detailed, regulatory language, 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 and safety and the environment.
3. Approvals occur prior to commencement of activities.

### **B** Plan Elements

1. Well Spacing
  - a) Owner identifies zones that may be tested and stimulated by hydraulic fracturing.
  - b) Owner identifies the proposed location of the well relative to unit boundaries.
  - c) Owner identifies and/or regulator evaluates the distance to offset wells that penetrate the target producing zone or impacted strata within the “area of potential impact”, to determine if proximal wellbores are potential conduits for out-of-zone migration of stimulation fluids, and to implement corrective action when necessary.
  - d) Owner attests, and/or regulator affirms, that there are no known pathways (natural or wellbore) to convey stimulation fluids or gas from “impacted strata” into protected groundwater based upon an assessment of the area of potential impact.
  - e) Establish standards for conducting wellbore deviation and inclination surveys.
2. Wellbore Construction
  - a) Owner provides, and/or regulator approves, a casing and cementing plan that demonstrates how protected groundwater and potentially productive zones will be effectively isolated.
  - b) Owner provides and/or regulator approves a casing and cementing plan that addresses how anticipated hazards will be addressed.
3. Well Stimulation
  - a) Owner provides information about the hydraulic fracturing plan specified (e.g., anticipated treatment pressure estimation or calculation of anticipated fracture length and height).
  - b) Owner provides information regarding anticipated base fluid including anticipated source and volume of water, if applicable.
  - c) Owner attests, or regulator affirms, that the intervening zone contains adequate confining layer(s) 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 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 public 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 diverter system if drilling on air, or other defined circumstances (e.g., drilling surface hole 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 standards for emergency response planning.

# III. Drilling-Well Construction

## **A** Performance Objectives; Examples:

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 standards for mix water quality.
4. Establishes authority to require specific blends to isolate problematic zones (such as corrosive H<sub>2</sub>S-bearing zones).
5. 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 standards for centralization of casing.
5. Specifies when an owner is required to notify an inspector prior to installing casing and/or commencement of cementing operations.
6. Establishes conditions under which further assessment and corrective action may be necessary (e.g., circulation problems or other indicators of deficient/defective cement).
7. Establishes process for regulatory approval of a plan for corrective action if there are indications of deficient or defective cement.
8. Specifies when cement evaluation logs or other diagnostic tests should be performed.
9. Specifies notifications and actions when tests demonstrate that performance objectives are not satisfied.
10. Establishes minimum WOC time standard based on compressive strength criteria.
11. 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 public safety or 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 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 cementing.
  - e) 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.
4. Production Casing
- a) Establishes a minimum standard for the height of cement above the uppermost perforation of the production casing or top of the production zone, or upper most flow zone.
  - b) Hydrocarbon-bearing zones above the target producing zone, must be isolated if necessary, to prevent annular over-pressurization (if not isolated using intermediate casing).
  - c) Establishes additional standards for wells with a limited intervening zone.

## **J** Assessment of Mechanical Integrity After Each Casing String is Emplaced and Cemented

1. Establishes authority to require 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. Establishes deadline, certification process, and confidentiality provisions for required records.
2. 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).
3. Establishes log and reporting requirements for geologic information (e.g., mud log records, wire line logs, 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.
4. 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

1. Specifies when an owner 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.

## **C** Hydraulic Fracturing Operations

1. Specifies which casing strings may be perforated for stimulation purposes.
2. Establishes criteria for continuous monitoring of wellbore integrity 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.

## **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 public health and safety.

### 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 braden head pressures are monitored to detect M.I. failures and potential annular over-pressurization).
2. Identifies when owner must notify Regulator if M.I. failures and/or annular over-pressurization are detected.
3. Process defined to prevent annular over-pressurization.

### 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 placed in accordance with approved methods.
2. The protected groundwater aquifers are sealed using approved plugging materials that are placed 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) Defines when plugging operations can commence relative to plan approval is approved.
2. Timeframes
  - a) Establishes timeframes for plugging dry holes.
  - b) Establishes timeframes for plugging inactive wells.
  - c) Establishes process for extensions and suspension of extensions.

3. Temporary inactive (suspended) status
  - a) Establishes a process 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 wellbore 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
  - a) Establishes regulator notification requirements.
  - b) Establishes criteria for plugging 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.