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Oil and Gas Well Construction Rules

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Well Construction Rules

1501:9-1-01 General Provisions

A. Definitions:

- (1) "Drive pipe"—A casing string that is driven through unconsolidated sediment to stabilize the borehole and isolate associated groundwater.
- (2) "Mine string"— A string of casing set and cemented to isolate a mine void, rubble zone, or a mined coal seam within the limits of an active mining operation.
- (3) "Conductor casing"—One or more strings of casing set and cemented to accomplish one or more of the following well construction objectives:
 - a. Stabilize unconsolidated sediments, or
 - b. Isolate shallow aquifers that provide ground water for water wells and springs in the vicinity of the well when drilling on air, or
 - c. Isolate groundwater before penetrating the workings of an active underground mine, and
 - d. Provide a base for an air body for diversion of shallow naturally occurring natural gas including coalbed methane.
- (4) "Surface casing"—A string of casing set and cemented to isolate and protect the deepest underground source of drinking water (USDW) and to serve as a base for well control equipment.
- (5) "Intermediate casing"—One or more strings of casing set after surface casing has been cemented through the base of the deepest USDW, but before drilling into the permitted hydrocarbon reservoir(s) to isolate hydrocarbon or brine bearing flow zones, stabilize the borehole, to isolate protected groundwater if encountered after drilling below surface casing, or serve as a base for well control equipment.
- (6) "Liner"—A string of casing set and cemented which does not extend to surface. Liners are anchored or suspended inside the previous casing string and may serve the purpose of intermediate or production casing strings.
- (7) "Production casing"—A string of casing set to isolate the permitted hydrocarbon bearing reservoir(s), and other pressurized flow or corrosive zones not effectively isolated by previous casing(s).
- (8) "Tail cement"—The last, typically higher density slurry pumped during primary cementing operations to seal the casing seat and isolate specific intervals providing faster thickening times and higher early compressive strength.
- (9) "Lead cements"—The first, typically less-dense slurry pumped during primary cementing operations to seal intervals above those sealed by the tail cement and to reduce the hydrostatic pressure of the cement slurry column at the casing seat while the slurry sets.

- (10) "Underground Source of Drinking Water (USDW)" means...An aquifer or portion of an aquifer that supplies any public water system or that contains a sufficient quantity of ground water to supply a public water system, and currently supplies drinking water for human consumption, or that contains fewer than 10,000 mg/l total dissolved solids and is not an exempted aquifer.
- (11) "Well integrity" means the quality or condition of a well being structurally sound with competent pressure seals by the application of technical and operational solutions that prevent uncontrolled fluid release throughout the well life cycle.
- (12) "Annulus" means the space between a borehole and tubulars or between tubulars where fluid can flow.
- (13) "Minimum internal yield pressure" means the minimum internal pressure at which permanent casing deformation could take place assuming no external pressure.
- (14) "Potential flow zone" means any zone in a well where hydrocarbons can flow when wellbore pressure is less than pore pressure and isolation of such zones is necessary to;
- a. protect hydrocarbons that may be present in commercial quantities; or
 - b. prevent over-pressurization of the surface casing annulus, or
 - c. maintain well control when drilling on fluid below the zone

1501:9-1-08 Well Construction

A. General:

All wells shall be constructed in a manner that is approved by the chief of the division of oil and gas as specified by these rules, permit conditions and approved work plans submitted as part of the permit application. Every well must be constructed in a manner that effectively achieves the performance objectives listed in Section 1509.17 of the ORC. When this Section does not detail specific methods to achieve these objectives, the operator shall make every effort to use sound design and effective industry practices.

B. Field Standards:

The chief may establish alternative well construction standards that are well, field, or play-specific by permit condition, to ensure protection of public safety or the environment.

C. Drilling Fluids:

- (1) All intervals drilled prior to reaching the USDW protective depth as defined by the approved surface casing program must be drilled with air, fresh water, a fresh water based drilling fluid, or a combination of the above. Only additives suitable for drilling through potable water supplies may be used while drilling these intervals.

- (2) The chief may require the use of a freshwater based drilling fluid and specify its characteristics by permit condition, while drilling any interval prior to reaching the USDW protective depth, based on regional knowledge of groundwater resources, well control, or safety factors.
- (3) Below cemented surface casing, other drilling fluids may be utilized.

D. Casing Standards:

- (1) All casing installed in any well shall be steel alloy casing that has been manufactured to API 5CT Specification for Casing and Tubing (Eighth Edition, July 1, 2005; effective date January 1, 2006) or ASTM Specification A500/A500M-07 standards and has a minimum internal yield pressure rating designed to withstand at least 1.2 times the maximum pressure to which the casing may be subjected.
 - a. New casing must meet minimum performance standards outlined in API Specification 5CT or ASTM Specification A500/A500M-07. The minimum internal yield pressure rating shall be based upon engineering calculations listed in API specification 5C-2
 - b. Reconditioned casing that is permanently set in a well shall be hydrostatically pressure tested with an applied pressure at least 1.2 times the maximum internal pressure to which the casing may be subjected, based upon known or anticipated subsurface pressure, or pressure that may be applied during stimulation, whichever is greater and assuming no external pressure. The casing must be marked to verify the test status. The owner shall provide a copy of the test results to the inspector before the casing is installed in the well.
 - c. Where subsurface reservoir pressure is unknown and cannot be reasonably anticipated the owner shall assume a pressure gradient of 0.45 psi per foot in a fully evacuated hole, under shut-in conditions.
 - d. All hydrostatic pressure tests shall be conducted pursuant to API Specification 5CT or other method(s) approved by the chief.
- (2) Reconditioned casing cannot be set in a well unless it has passed an approved hydrostatic pressure and drift test or has otherwise been approved by the inspector. The inspector shall reject casing that is excessively pitted, patched, bent, corroded, crimped, or if threads are severely worn or damaged.
- (3) In order to verify casing integrity and proper cement displacement, the operator shall pressure test each cemented casing string greater than 200 feet long. Upon landing the wiper plug, the operator shall increase displacement pressure by 500 psi and hold pressure for five minutes. If pressure declines by ten (10%) percent or more, or there is flow inside the casing after releasing pressure, casing integrity and cement placement must be further evaluated for corrective action.

E. Formation Integrity Tests:

- (1) The chief may require a formation integrity test after drilling out below the surface casing and/or the intermediate casing seat if the pressure gradient of the permitted hydrocarbon reservoir exceeds 0.5 pounds per square foot, or is unknown for new plays or fields.

F. Surface Water Infiltration:

- (1) Before drilling out below the first casing string, a liquid-tight cellar must be constructed to prevent surface infiltration of fluids. If a reserve pit is used to contain cuttings and drilling fluids, the flow ditch from the cellar to the reserve pit must also be liquid tight.

G. Mouse and Rat Holes:

- (1) If a rat and/or mouse hole is used, it must be constructed of liquid tight steel pipe. The annulus must be sealed in a manner that effectively prevents fluids from entering the annular space.

H. Wellbore Diameters:

- (1) With the exception of drive pipe, the diameter of each section of the wellbore must be at least one inch greater than the outside diameter of casing collar to be installed, unless otherwise approved by the chief.
- (2) The well bore diameter must be consistent with manufacturer's recommendations for all float equipment, centralizers, packers, cement baskets, and all other equipment run into the borehole on casing.

I. Borehole Conditioning:

- (1) Circulation shall be established in all borehole intervals drilled through USDWs, prior to pumping cement. If circulation is not maintained or if other indicators suggest cement placement or quality may be compromised, the inspector may require testing and remedial actions before activity may resume.
- (2) For borehole intervals drilled for intermediate or production casing, conditioning fluid and cement volumes shall be adequate, with the addition and use of appropriate float equipment on the casing string, to achieve static conditions at the end of placement.
- (3) Subsurface voids: Where underground mine voids, solution voids or other geologic features render circulation infeasible; the operator must install a cement basket as close as possible above the top of the void or thief zone. Mine strings must be cemented above and below the mine void in accordance with Section M (ii and iii).

J. Cement Standards:

- (1) All cement placed into the wellbore must be Portland cement that is manufactured to meet API Specification 10 A (Edition 24, December 2010; Effective: June 1, 2011) or ASTM C150/C150M-11 standards.
- (2) Cemented conductor, mine, and surface casing strings must remain static until the all cement has reached a compressive strength of at least 500 psi before drilling the plug, or initiating a test.
- (3) The tail cement for all intermediate and production casings and liners must remain static until the cement has reached a compressive strength of at least 500 psi before drilling out the plug or initiating a test. Lead cements with volume extenders, may be used to seal these strings, but in no case shall the cement have a compressive strength of less than 100 psi at the time of drill out nor less than 250 psi 24 hours after being placed.
- (4) The density of the cement slurry shall be based upon a laboratory free fluid separation test demonstrating an average fluid loss no more than six milliliters per 250 milliliters of cement tested in accordance with API RP Specification 10 A standards. The chief may require, by permit condition, a specific cement mixture to be used in any well or any area if evidence of local conditions indicate a specific cement is necessary.
- (5) An operator shall ensure that the cement mix water chemistry is proper for the cement slurry designs. An operator's representative shall be on site observing the cement mixing equipment for the entire duration of the cement mixing and placement to ensure that cement slurry design parameters are followed.
- (6) Sulfate resistant cement shall be used whenever necessary to protect the casing string and prevent the migration of hydrogen sulfide. When drilling in a township where hydrogen sulfide occurs commonly in specific intervals, the chief will require the use of sulfate resistant cement by permit condition.
- (7) Compressive strength test requirements.
 - a. Cement mixtures for which published performance data are not available must be tested by the operator or service company and approved by the chief prior to usage. Tests shall be made on representative samples of the basic mixture of cement and additives used, using distilled water or potable tap water for preparing the slurry. The tests must be conducted using the equipment and procedures adopted by the American Petroleum Institute, as published in the current API Specification 10 A standards (*June 1, 2011*). Test data showing competency of a proposed cement mixture to meet the above requirements must be furnished to the inspector prior to the cementing operation. To determine that the minimum compressive strength has been obtained, operators shall use the typical performance data for the particular cement mixture used in the well at the following temperatures and at atmospheric pressure:
 - b. For the tail cement, the test temperature shall be within 10 degrees Fahrenheit of the formation equilibrium temperature of the cemented interval.

- c. For the lead cement, the test temperature shall be the temperature found 100 feet below the ground surface level, or 60 degrees Fahrenheit, whichever is greater.

K. Centralizer Standards;

- (1) All bowspring centralizers shall meet API Specification 10 D standards (March 1, 2002).
- (2) All rigid centralizers shall meet API Specification 10 TR4 standards (May 1, 2008)

L. Notification:

- (1) An operator must notify the inspector at least 24 hours prior to setting any casing or liner string and before commencing any casing cementing operation(s) pursuant to this Section.

M. Casing Strings:

- (1) Drive pipe: Drive pipe may be driven through unconsolidated materials and need not be cemented if there is no annular space.
- (2) Mine string:
 - a. Casing through an active underground mining operation:
 - i. Any person who drills a well within the limits of an active underground mining operation shall construct the well in a manner that protects personnel working in the mine, and, if possible, shall locate the well so as to penetrate a pillar, a barrier, or perimeter coal.
 - ii. If a well is drilled within the limits of an active underground mining operation that may penetrate the excavations of a mine, and groundwater has been encountered below the base of the conductor casing, the hole shall be reduced fifteen feet above the roof of the mine. This string of casing shall be cemented to surface to shut off all groundwater. Then drilling shall continue to a point at least thirty but no more than 50 feet below the floor of the mine and another string of casing shall be set and cemented.
 - iii. If no groundwater is encountered between the base of the conductor casing or drive pipe and the shoulder above the roof of the underground mine the hole shall be drilled at least thirty but no more than fifty feet below the floor of the underground mine and a string of casing shall be set and cemented at this point.
 - iv. After drilling through underground mine void or rubble zone casing shall be set at least 30 feet but no more than fifty feet below the base of the mine void or rubble zone.
 - b. Water protection: A mine string may not serve as the only water protection casing. Where a mine strings isolates one or more water-bearing zones, either

surface or intermediate casing must be cemented to surface inside the mine string.

- c. Centralization: Each mine string shall be centralized with at least one centralizer above the coal seam or mine void.
 - d. Guide shoe: Each mine protection string shall be equipped with a guide shoe or other appropriate device to prevent deformation of the bottom of the casing.
 - e. Cementing the mine string:
 - i. If a mine void or rubble zone is encountered, the operator shall equip the mine string with a cement basket as close to the top of the void as practical.
 - ii. The interval from the casing seat to the base of the coal seam shall be cemented.
 - iii. Cement shall be placed on top of the basket by pour string or pumping from surface.
- (3) Conductor casing:
- f. Conductor casing shall be set when necessary to:
 - i. Stabilize unconsolidated sediments,
 - ii. Isolate shallow aquifers that provide ground water for water wells and springs in the vicinity of the well, or
 - iii. Isolate ground water before penetrating the working of an active underground mine.
 - iv. Provide a base for equipment to divert shallow, naturally occurring natural gas.
 - a. Conductor casing shall be cemented to surface.
 - b. If circulated cement drops, cement shall be emplaced from surface by a method approved by the inspector.

(4) Surface casing

- a. An operator shall set and cement sufficient surface casing at least 50 feet below the base of the deepest USDW as specified by permit, unless otherwise approved by the chief. Surface casing must be cemented before drilling through hydrocarbon bearing zones unless approved by the chief. For the purposes of this rule, hydrocarbon bearing zones shall include all formations that have historically, are currently, or are anticipated to be commercially productive. This definition may also include zones which contain concentrations of total dissolved solids exceeding 10,000 milligrams per liter, or non-commercial quantities of hydrocarbons which the chief has determined are likely to cause adverse environmental impacts or present substantial safety risks.
- b. Sufficient cement shall be used to fill the annular space outside the casing from the seat to the ground surface or to the bottom of the cellar.
- c. If cement is not circulated to the ground surface or the bottom of the cellar, and the top of cement cannot be measured from surface, the operator shall perform tests as approved by the inspector. The inspector shall be notified prior to running the required evaluation tools. After the nature of the well construction deficiency is determined, the operator shall contact the inspector and obtain approval for the procedures to be used to perform any required additional cementing operations. Surface casing may not be perforated unless intermediate casing is set and cemented to surface, unless authorized by the inspector.
- d. If remedial options fail and the chief determines that USDWs are not adequately isolated or protected, the chief may issue an administrative order suspending further drilling operations. If the chief determines additional remedial measures will not isolate and protect the USDW an administrative order will be issued requiring the well to be plugged.
- e. Surface casing shall be centralized within 50 feet of the seat, above and below a stage collar or diverting tool, if run, within the lowermost joint of conductor or drive pipe, and as necessary to centralize casing adjacent to protected water aquifers.
- f. For surface holes drilled through glacial drift deposits that exceed 100 feet in thickness, a guide shoe shall be run on the surface casing.
- g. In areas, where USDWs cannot be mapped, the chief shall establish by permit condition a minimum surface casing depth to ensure that casing is installed and cemented below the deepest local stream base.

As an alternative, an operator may install and cement to surface conductor casing at least 50 feet below the base of the lowest spring or deepest water well developed for any legitimate purpose, based upon an inventory of water supplies within a 500 foot radius of the proposed oil and gas well. If there are no springs or water wells within the 500 foot radius, conductor casing shall be set and cemented at a minimum depth of 100 feet. After conductor casing is set through the deepest useable water zone and cemented to surface, the operator shall set and cement to surface a surface casing string through water zones that may include brackish or brine bearing zones. This casing string must be set and cemented to surface before drilling into zones that can reasonably be expected to contain hydrocarbons in commercial quantities.

(5) Alternative surface casing requirements:

An alternative method of protecting USDWs may be approved upon written application to the chief. The operator shall state the reason for the alternative USDW protection method and outline the alternate program for casing and cementing through the deepest USDW. Alternative programs for setting more than specified amounts of surface casing for well control purposes may be requested on a field or area basis. Alternative programs for setting less than specified amounts of surface casing will be authorized on an individual well basis only. The chief may approve, modify, or reject the proposed program. The chief shall reject the proposal by order if the operator has not demonstrated that the alternative casing plan will achieve all performance objectives listed in Section 1509.17 ORC. The operator may file an appeal with the Oil and Gas Commission. An operator shall obtain approval of any alternative program before commencing operations.

(6) Intermediate casing:

Intermediate casing may be set at the discretion of the operator, or as required by permit condition.

- a. The operator must set and cement intermediate casing in a competent formation:
 - i. if ground water containing less than 10,000 mg/L Total Dissolved Solids is encountered below the base of cemented surface casing; or
 - ii. when drilling to strata beneath gas storage fields consistent; or
 - iii. when drilling to permitted hydrocarbon zones deeper than the Silurian "Clinton sandstone" in eastern Ohio; such casing shall be set through the Mississippian Berea Sandstone, or 1000 feet whichever is greater.
- b. For each intermediate string of casing that is permanently set in the wellbore, tail cement must extend from the seat to a point at least 500 true vertical feet above the casing seat, or to a point at least 200 feet above the seat of the next larger diameter casing string.
- c. If the intermediate borehole penetrates one or more potential flow zones, cement shall be placed behind intermediate casing through and at least 200 feet above the uppermost flow zone. The cement shall reach a compressive strength of 500 psi before drill out. Annular pressure shall be measured prior to drill out to verify isolation of the flow zone,

- d. If the cement placement evaluation indicates inadequate coverage (ie. fluid returns, lift pressure, annular pressure) of any productive horizon, any flow zone, or any strata containing protected water, the operator shall obtain approval of the inspector for the operator's proposed plan for determining top of cement and/or performing additional cementing operations.
 - e. Intermediate casing shall be centralized. In non-deviated holes, centralizers shall be installed within 50 feet of the seat, above and below a stage collar or diverting tool, if run, and through potential flow zones. In deviated holes, the operator shall provide additional centralization. If cement extends into a larger diameter casing string, the intermediate casing string must be centralized within the larger diameter casing. The chief may approve an alternative centralization plan that is sufficient to ensure centralization of intermediate casing through potential flow zones.
 - f. Liners may be set and cemented as intermediate casing provided that the cemented liner has a minimum of 200 (100') true vertical depth feet of cemented lap within the next larger casing, and the liner top is pressure tested to a level equal to or higher than the maximum anticipated pressure to be encountered in the interval to be drilled below the liner. The test pressure may not decline by more than ten percent during the 30 minute period. If at the end of a 30 minute pressure test, the pressure has dropped by more than ten percent, further operations cannot resume until the condition is corrected, and verified by a pressure test.
- (7) Production casing and liners
- a. Cemented completions:
 - i. The producing casing shall be cemented with sufficient cement to fill the annular space to a point at least 500 true vertical feet above (i) the seat in an open-hole vertical completion or the uppermost perforation in a cemented vertical completion, or (ii) the heel of a horizontal well. If any potential flow zone, including strata that may contain hydrocarbons in commercial quantities, or hydrogen sulfide-bearing zone is present, the casing shall be cemented in a manner that effectively seals off all such horizons or strata.
 - ii. When cementing the production string of a well that will be stimulated by hydraulic fracturing, and the uppermost perforation is less than 500 feet below the base of the deepest USDW, sufficient cement shall be used to fill the annular space outside the casing from the seat to the ground surface or to the bottom of the cellar. If cement is not circulated to the ground surface or the bottom of the cellar, the operator shall notify the inspector and perform tests approved by the inspector. After the top of cement outside the casing is determined, the operator or his representative shall contact the inspector and obtain approval for the procedures to be used to perform any required additional cementing operations.
 - iii. Liners may be set and cemented as production casing provided that the cemented liner has a minimum of 200 true vertical depth feet of

cemented lap within the next larger casing, and the liner top is pressure tested to a level that is at least 500psi higher than the maximum anticipated pressure to be encountered by the wellbore during completion and production operations. The test pressure may not decline by more than ten percent during the 30 minute period. If at the end of a 30 minute pressure test, the pressure has dropped by more than ten percent, further operations cannot resume until the condition is corrected, and verified by a pressure test.

- iv. The production casing string or liner must be centralized in a manner that will provide for proper zonal isolation by the cement. Production casing shall be centralized at the casing seat, above and below a stage collar or diverting tool, if run, and through and above hydrocarbon bearing zones. In deviated holes, the operator shall provide additional centralization.
 - v. If operations indicate inadequate cement coverage or isolation of the hydrocarbon bearing zones, the operator shall obtain approval of the inspector for procedures to determine the top of cement and/or perform corrective actions.
- b. Packer completions:
- i. Packer or other non-cemented completions may be used in the place of cemented completions. If intermediate casing is run with this type of completion, the intermediate casing cementing must meet the cementing guidelines set forth in Section M (7). If intermediate casing is not run, a multi-stage cementing tool must be run above the top external packer and cemented to fill the annular space back of the casing to the surface or to a point at least 500 feet above the packer or casing seat. The chief may review alternative completion proposals. Any approved alternative must meet the well construction performance objectives listed in section 1509.17 of the ORC.

N. Annular Pressure:

- (1) Wellhead assemblies shall be used on wells to maintain surface control of the well. Each component of the wellhead shall have a working pressure rating equal to the anticipated operating pressure to which the particular component might be exposed during the course of drilling, testing, completing, or producing the well
- (2) The valve on the surface-production casing annulus, or surface-intermediate casing annulus shall be accessible and equipped with a pressure gauge and properly functioning pressure relief valve set at or below the hydrostatic pressure at the surface casing seat assuming a pressure gradient of 0.433 psi times the height of the groundwater column. When the hydrostatic head at the casing seat is unknown, the surface-production casing is assumed to be over-pressurized when annular pressure measured at surface exceeds 0.303 multiplied by the length of the surface casing. If the inspector approves perforation of surface casing and intermediate casing is not installed and cemented, the allowable

annular pressure measured at surface in pounds per square inch will be established by multiplying the depth of the uppermost perforation by .303.

- (3) If any time after installation of the wellhead assembly, the annular pressure exceeds the prescribed pressure or the releases the pressure relief valve, the operator shall immediately notify the inspector.
- (4) The inspector shall approve tests or logging procedures to evaluate the cause of over-pressurized conditions and approve a plan for remedial action. If remedial cementing, replacement of defective casing, or implementation of other mechanical or operational barriers cannot eliminate over-pressurized conditions, the well shall be plugged.
- (5) During stimulation or workover operations, all annular pressures shall be pressure-monitored. Stimulation or workover operations shall be immediately suspended for any inexplicable pressure deviation above anticipated increase caused by pressure or thermal transfer. In the event that stimulation fluids circulate, or annular pressures deviate from anticipated, the operator shall immediately notify the inspector and acquire approval for remediation of casing or cement. If the chief determines that the stimulation of the well has resulted in irreparable damage to the well, the chief shall order that the well be plugged and abandoned within thirty days of issuance of the order.

O. Well Construction Records:

- (1) Within 60 days after drilling to total depth, a legible copy of all cement job logs must be filed with the chief furnishing complete data documenting the cementing of all cemented casing strings on a form approved by the chief and signed the operator of the well or his duly authorized agent having personal knowledge of the facts, and representatives of the cementing company performing the cementing job, attesting to compliance with the cementing requirements.
- (2) Each job log must include the following information: Date cemented, mix water temperature and pH, whether the borehole circulated prior to cementing, hole diameter in inches, casing outer diameter in inches, casing length in feet, float equipment depth in feet, basket depth in feet, cement type, additives by percent or unit volume, volume of cement in sacks, average slurry density in pounds per gallon, slurry volume in barrels, displacement volume in barrels, pumping rates in barrels per minute, displacement pressure in pounds per square inch, casing test pressure in pounds per square inch, test pressure after five minutes, and whether cement circulated to surface, or not.