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**Rules of**  
**Department of Natural Resources**  
**Division 23—Division of Geology and Land Survey**  
**Chapter 5—Heat Pump Construction Code**

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**Title 10—DEPARTMENT OF  
NATURAL RESOURCES**  
**Division 23—Division of Geology and  
Land Survey**  
**Chapter 5—Heat Pump Construction  
Code**

*Editor's Note: Forms mentioned in this chapter may be found following 10 CSR 23-6.*

**10 CSR 23-5.010 Definitions**

*PURPOSE: This rule specifically defines words used in Chapter 5 concerning heat pump wells, otherwise the definitions contained in 10 CSR 23-1.010 apply.*

(1) Horizontal closed-loop heat pump well means a trench or pit usually parallel to the horizon and more than ten feet (10') in depth into which a closed-loop pipe is placed for the purpose of heat transfer. Closed-loop heat pump systems installed in trenches or pits ten feet (10') or less in depth are exempt from these rules.

(2) Open-loop heat pump water supply well means a well drilled to supply water for the purpose of heat transfer. This type of well is to be constructed to domestic well standards, 10 CSR 23-3.010—10 CSR 23-3.100 if it produces less than seventy (70) gallons per minute or to public water supply standards if it produces more than seventy (70) gallons of water per minute.

(3) Vertical closed-loop heat pump well means the borehole perpendicular to the horizon deeper than ten feet (10') into which a closed-loop pipe is placed for the purpose of heat transfer.

(4) Water return well means a well constructed for the purpose of returning water that has passed through the heat pump machine to the same aquifer that it was produced from in the open-loop water supply well.

*AUTHORITY: sections 256.603, 256.606 and 256.626, RSMo 1994.\* Emergency rule filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Original rule filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed Nov. 1, 1995, effective June 30, 1996.*

*\*Original authority: 256.603, RSMo 1985, amended 1991; 256.606, RSMo 1991; and 256.626, RSMo 1985, amended 1991.*

**10 CSR 23-5.020 Certification and Registration of Heat Pump Systems**

*PURPOSE: This rule sets required standards for certification report form submittal.*

(1) A certification report form, supplied by the division, shall be used to report the construction of open-loop and closed-loop heat pump systems which utilize trenches, or pits and/or wells as loop installation points. One (1) certification report form per heat pump system shall be completed and submitted to the division by the permittee within sixty (60) days after completion of the system. The certification report form shall be accompanied by the certification fee (see 10 CSR 23-2 for fees). The permittee shall furnish the well owner one (1) copy, the division one (1) copy and retain one (1) copy in the permittee's files. The report form shall contain all required information. Heat pump systems that utilize trenches or bodies of water to house the closed-loop are required to submit one (1) certification report form for the system. Heat pump systems that utilize wells are required to submit one (1) certification report form.

(2) The certification process involves the review of the certification report form to be sure that the heat pump system meets all construction requirements necessary for the specific area the system has been constructed. The minimum construction standards were written to protect Missouri's groundwater and to help ensure that the construction of the system does not constitute a threat to this resource.

(3) Upon successful completion of the review of the certification report forms, a certification number, which indicates that the heat pump system has met the minimum standards set in these rules, will be sent to the land owner.

(4) The registration process involves the documentation of certain types of activities according to the requirements and reported on forms supplied by the division.

(5) A registration report form, supplied by the division, shall be used to report major repairs and alterations of heat pump systems and the plugging of heat pump systems and must be submitted to the division by the permittee within sixty (60) days after completion of the appropriate operations. The registration report form shall be accompanied by the registration fee. The permittee shall furnish the well owner one (1) copy, the division one

(1) copy and retain one (1) copy in the permittee's files. The report form shall contain all required information.

*AUTHORITY: sections 256.606, 256.623 and 256.626, RSMo 1994.\* Emergency rule filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Original rule filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed Nov. 1, 1995, effective June 30, 1996.*

*\*Original authority: 256.606, RSMo 1991 and 256.623 and 256.626, RSMo 1985, amended 1991.*

**10 CSR 23-5.030 General Protection of Groundwater Quality and Resources**

*PURPOSE: This rule prevents the use of heat pump wells for any other purpose.*

(1) Heat pump wells once constructed shall not be converted to any other type of well, except by written approval by the division.

(2) It is the obligation and responsibility of the heat pump installation contractor to ensure that the heat pump system is constructed according to the rules. On systems that utilize wells, the heat pump installation contractor is responsible for the integrity of the annular seal for a period of time from the date of certification to three (3) years after that unless it can be shown that the well seal has been damaged by other persons.

*AUTHORITY: sections 256.606 and 256.626, RSMo Supp. 1991.\* Emergency rule filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Original rule filed Aug. 17, 1993, effective March 10, 1994.*

*\*Original authority: 256.606, RSMo 1991 and 256.626, RSMo 1985, amended 1991.*

**10 CSR 23-5.040 Location of Heat Pump Wells**

*PURPOSE: This rule sets standards for the placement of heat pump wells.*

(1) A vertical heat pump well shall be located on a site which has good surface drainage and prevents the accumulation of water within ten feet (10') of the well and any buried pipes.

(2) Vertical heat pump wells shall not be located within certain distances from pollution or contamination sources. A vertical heat pump well shall be at least—



(A) Three hundred feet (300') from a storage area for commercial fertilizers or chemicals, landfill, lagoon, or above-ground or underground storage tank for petroleum, petroleum products or chemicals.

(B) One hundred feet (100') from a below-grade manure storage area, cesspool, unplugged abandoned well, subsurface disposal field (lateral field), grave, building or yard used for livestock or poultry, privy or other contaminants that may drain into the ground.

(C) Fifty feet (50') from an existing operating well, septic tank, buried sewer, a pit or unfilled space below ground surface, a sump, except that a well may be drilled closer than fifty feet (50') to a basement or heat pump well.

(3) Horizontal heat pump wells should be at least two feet (2') above or below any other intersecting underground piping (to prevent freezing of the water lines) or wiring on the property, except a soaker pipe for the heat pump system used to keep the soil moisture constant.

(4) A variance may be granted if set back distances cannot be met. The variance must be obtained in advance from the division.

*AUTHORITY: sections 256.606 and 256.626, RSMo 1994.\* Emergency rule filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Original rule filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed Nov. 1, 1995, effective June 30, 1996.*

*\*Original authority: 256.606, RSMo 1991 and 256.626, RSMo 1985, amended 1991.*

### 10 CSR 23-5.050 Construction Standards for Closed-Loop Heat Pump Wells

*PURPOSE: This rule describes the minimum standards for a properly constructed closed-loop heat pump well.*

(1) Casing Material. If permanent casing is needed in a heat pump well, it must meet standards set out in 10 CSR 23-3.030 for steel and 10 CSR 23-3.070 for plastic and must be grouted full-length.

(2) Heat Pump Loop Material. In a closed-loop heat pump well, the material used to make up the heat-exchange loop that is placed in the ground or into a body of water must be composed of high density polyethylene or polybutylene pipe and must be installed and grouted without delay upon completion of drilling of each well.

(A) High Density Polyethylene Pipe. This pipe must be manufactured in accordance with dimensional specifications of ASTM D-2513 or ASTM F-714 and must have a minimum cell classification of PE345434C or PE355434C when tested under ASTM D-3350 to be acceptable for use in closed-loop heat pump systems.

(B) Polybutylene Pipe. This pipe must be manufactured in accordance with ASTM D-2581. The pipe material must be—

1. Either Class B (general purpose and dielectric, in colors) or Class C (weather resistant, black in color containing not less than two percent (2%) carbon black);

2. Type II (density, ninety-one thousandths to ninety-two thousandths (.0091-.0092) grams per centimeter (g/cm));

3. Grade 1 (flow rate twenty-five thousandths to seventy-five thousandths (.0025-.0075) gallons per ten (10) minutes (g/10 min)).

(3) Connecting Closed-Loop Pipe. Polyethylene and polybutylene pipe must be thermally fused according to the pipe manufacturer's specifications and must not leak after assembly.

(4) Heat Transfer Fluid. The fluid used inside the closed-loop assembly must be approved by the board and meet the following standards:

(A) Heat transfer fluids must be composed of—

1. Pure glycerine solution—glycerine must be ninety-six and one-half percent (96.5%) United States pharmacopoeia grade;

2. Food grade propylene glycol;

3. Dipotassium phosphate;

4. Sodium chloride;

5. Potassium acetate;

6. Methanol;

7. Water;

8. Ethanol; or

9. Other fluids may be used if approval by the division is received in advance;

(B) The fluid as it is used in a diluted state in the closed-loop must have the following properties:

1. Be ninety percent (90%) biodegradable;

2. Demonstrate low corrosion to all materials common to ground source heat pump systems;

3. Be homogeneous, uniform in color, free from lumps, skins and foreign material that would be detrimental to fluid usage;

4. Not have a flash point lower than ninety degrees Celsius (90°C);

5. Not have a five (5)-day biological oxygen demand (BOD) at ten degrees Celsius

(10°C) that exceeds two-tenths (0.2) gram oxygen per gram nor be less than one-tenth (0.1) gram oxygen per gram;

6. Not have a toxicity that is less than lethal dose (LD) fifty (50) oral-rats of five (5) grams per kilogram; and

7. Show neither separation from exposure to heat or cold, nor show an increase in turbidity; and

(C) While this rule attempts to define antifreeze fluids that will protect the environment, it is the responsibility of the permittee to become familiar with safe and proper use of these fluids and to take necessary precautions to ensure groundwater protection.

(5) Hole Size. The hole size for heat pump wells that are grouted full-length with high solids bentonite slurry (see 10 CSR 23-5.050(9)(A)) must be of sufficient size to allow placement of the pipe and placement of a tremie to emplace the high solids bentonite slurry. The slurry must fill the hole and surround all pipes. There must be at least one-half inch (1/2") between the hole and all pipes. If full-length high solids bentonite slurry is not used, then the following hole sizes are required:

(A) At least a six-inch (6") borehole when the loop pipe is one and one-quarter inch (1 1/4") or greater in diameter;

(B) At least a five-inch (5") borehole when the loop pipe is less than one and one-quarter inch (1 1/4") in diameter.

(6) Hole Depth. Closed-loop heat pump wells must not be deeper than two hundred feet (200'). A variance must be obtained in advance, from the division, to drill a heat pump well deeper than two hundred feet (200'). A heat pump well drilled in Area C (see 10 CSR 23-3.100(3)) that is less than two hundred feet (200') deep and cuts the Northview Formation must have a thirty-foot (30') grout plug set starting at ten feet (10') below the bottom of the Northview Formation. A map will be provided by the division showing the depth the grout plug must start. Follow the grouting requirement set out in 10 CSR 23-5.050(8) for grouting the interval above the Northview Formation. Total depth of a new heat pump well in Special Area 3 and Special Area 4 shall be determined in advance of drilling by the division. At any heat pump well being drilled, per division guidance, in which perchloroethylene (PCE) and/or trichloroethylene (TCE) is encountered in a pure-product phase (also known as dense non-aqueous phase liquid or DNAPL), drilling shall cease and the division shall be notified immediately. The division will determine further action.



(7) Heat Pump System Design. The heat pump system that utilizes wells must be designed so that the grout used to seal the wells does not dehydrate because of excessive heat caused by an improperly designed heat pump system.

(8) Grouting Depth of Vertical Heat Pump Wells. Grouting the annulus of a heat pump well is very important and must be completed immediately after the well is drilled due to cave-in potential in the uncased hole. Full-length grout is recommended and may be required (see section (5)) to prevent surface contamination from entering the drinking water aquifer through the borehole. The grout required for heat pump wells greater than two hundred feet (200') in depth must be determined by the division in advance. A variance form will be issued setting the grouting requirements. If the heat pump borehole is not grouted full-length, hole size requirements stated in section (5) must be followed and non-slurry bentonite plugs must be placed into the borehole. A plug (first plug) must be placed about forty feet (40') above the total depth of the borehole. This plug must be composed of bentonite chips or pellets utilizing at least one (1) bag of bentonite resulting in at least a five-foot (5') plug. Every forty feet (40') of borehole that exists above the first plug must have a plug set as described in this section. A near surface plug consisting of bentonite granules or powder must be set from a point ten feet (10') below the bottom of the trench, that connects the closed-loop to the heat pump machine, to the base of the trench. All bentonite plugs must be hydrated immediately after emplacement if they are in the unsaturated zone. All clean fill material placed between the bentonite plugs must be chlorinated. Heat pump wells in the Special Area 3 and Special Area 4 must be grouted full-length with thermal grout, placed from the bottom of the borehole up to the base of the trench.

(9) Approved Grout Materials. The following four (4) grout types are permitted for use in heat pump wells:

(A) Bentonite Slurry. High solids sodium bentonite slurry must be at least twenty percent to thirty percent (20%–30%) by weight solids to be used as grout. Thickened drilling mud or thinner bentonite slurry is strictly prohibited. Specialized pumps are required to pump a high solids bentonite slurry. When bentonite slurry is used, it must be applied in one (1) continual motion, through a tremie lowered to the grouting point. It is recommended that full-length grout be used in all vertical closed-loop heat pump wells. The

tremie pipe may be removed while the borehole is filled or removed afterward;

(B) Non-slurry Bentonite. Chipped or pelletized bentonite varieties that are designed to fall through standing water may only be used when sealing the annulus of a well that is below the water level in the saturated zone. Complete hydration is difficult to achieve when using dry non-slurry bentonite in the unsaturated zone. All non-slurry sodium bentonite varieties may be used in the unsaturated zone if the hole is dry and no bridging occurs. The dry bentonite must be hydrated after emplacement. The effective use of non-slurry bentonite as a sealing agent depends on the efficient hydration of the product;

(C) Thermal Grout Slurry. Grout containing at least seven and one-half percent (7.5%) by weight bentonite solids and no more than sixty-five percent (65%) by weight silica solids may be used as grout. The grout slurry mixture must exhibit a thermal conductivity greater than 0.85 Btu/hr. ft. degree F and permeability not more than  $1 \times 10^{-7}$  cm/s. Specialized pumps are required and the slurry mixture must be installed full-length through a tremie lowered to an initial grouting point within twenty feet (20') of the base of the borehole; and

(D) Other Grout. Other types of grout may be used if approval is granted in advance by the division.

(10) Wells That Encounter Karst Conditions. When a borehole encounters caves or large fractures, grouting may become difficult. Small fractures are effectively sealed by using chipped bentonite. Clean fill (gravel, sand, and the like) may be used to fill these intervals. If the borehole cannot be grouted as specified, it must be plugged and a new location chosen. The heat pump loop can be redesigned for shorter boreholes not encountering these conditions.

(11) Jetted Heat Pump Wells. Closed-loop heat pump wells that are jetted in Area 5 (see Figure 5) must not be deeper than seventy-five feet (75') and at least the upper ten feet (10') of borehole must be grouted.

(12) Heat Pump Wells in Special Area 3. Portions of Franklin County within and south of the city of New Haven are listed as Special Area 3 (Figures 7B and 7C, 10 CSR 23-3.100(7)) due to the contamination of portions of the aquifer by one (1) or more of the following chemicals of concern: tetrachloroethylene (PCE), trichloroethylene (TCE), PCE degradation products and TCE degradation products or other contaminants of the National Public Drinking Water Regu-

lations (NPDWR). In this area it is necessary to utilize more stringent construction standards for new heat pump wells that are drilled into the aquifer. In Special Area 3 a qualified and properly trained individual shall collect all groundwater samples for analysis of chemicals of concern.

(A) The division shall be consulted before constructing a new heat pump well in Special Area 3. The division will provide specific guidance on heat pump well drilling protocol and construction specifications on a case-by-case basis. The division must provide written approval for all new heat pump wells prior to construction.

(B) All drilling-derived fluids and solid materials shall be containerized and sampled before disposal in an appropriate location based on analytical results.

(C) At any heat pump well being drilled, per division guidance, in which PCE and/or TCE is encountered in a pure-product phase (also known as dense non-aqueous phase liquid or DNAPL), drilling shall cease and the division shall be notified immediately. The division will determine further action.

(13) Heat Pump Wells in Special Area 4. Portions of St. Charles County west of the city of Weldon Spring are listed as Special Area 4 (Figure 7D, 10 CSR 23-3.100(8)) due to the contamination of portions of the aquifer by one (1) or more of the following chemicals of concern: trinitrotoluene (TNT) and dinitrotoluene (DNT) at the Army Corps of Engineers (COE) site, 2,4,6-TNT, 2,4-DNT, 2,6-DNT, dinitrobenzene (1,3-DB), nitrobenzene (NB), nitrate, uranium, and trichloroethylene (TCE) at the Department of Energy (DOE) main site, uranium and 2,4-DNT at the DOE Quarry, or other contaminants of the National Public Drinking Water Regulations (NPDWR). In this area it is necessary to utilize more stringent construction standards for new heat pump wells that are drilled into or through the shallow aquifer defined as the Burlington Keokuk/Fern Glen formation(s) at the main site and the Kimmswick limestone at the DOE Quarry. In Special Area 4 a qualified and properly trained individual shall collect all groundwater samples for analysis of chemicals of concern. Sampling qualifications and training requirements will be determined in advance of sampling by the division and approval will be issued in written format.

(A) The division shall be consulted before constructing a new heat pump well in Special Area 4. The division will provide specific guidance on heat pump well drilling protocol





and construction specifications on a case-by-case basis. The division must provide written approval for all new heat pump wells prior to construction.

*AUTHORITY: sections 256.606 and 256.626, RSMo 2000.\* Emergency rule filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Original rule filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed July 13, 1994, effective Jan. 29, 1995. Amended: Filed Nov. 1, 1995, effective June 30, 1996. Amended: Filed Dec. 16, 2002, effective June 30, 2003. Emergency amendment filed March 21, 2005, effective April 1, 2005, expired Sept. 27, 2005. Amended: Filed Sept. 27, 2005, effective April 30, 2006. Amended: Filed Jan. 4, 2007, effective Aug. 30, 2007.*

*\*Original authority: 256.606, RSMo 1991 and 256.626, RSMo 1985, amended 1991.*

#### **10 CSR 23-5.060 Construction Standards for Open-Loop Heat Pump Systems That Use Groundwater**

*PURPOSE: This rule sets standards for open-loop heat pump systems that use wells to produce or return groundwater.*

(1) Open-loop heat pump systems and their installers that utilize existing surface water supply which is plumbed through the heat pump machine and returned to the same surface water supply are exempt from these rules.

(2) Open-Loop Heat Pump Systems and Groundwater Supply Wells. An open-loop heat pump uses groundwater produced from wells which are plumbed through the heat pump machine where the heat transfer of the groundwater is accomplished. The groundwater is then utilized at the surface or returned to the ground via a return well. Any new well utilized to supply water must meet the construction standards set out in 10 CSR 23-3. Any well that was constructed before October 1987, that is utilized as the water supply for an open-loop heat pump system is exempt from these rules, except that the surface disposal of the water may fall under the Division of Environmental Quality rules and the return of the produced water via a well must meet rules set out in this section.

(3) Surface Disposal of Used Water. After the water passes through the heat pump machine, it may be disposed of to the surface only if the water remains on the landowner's property. It may not be run to drainage that leaves

the property unless applicable permits are secured through the Water Pollution Control Program, Division of Environmental Quality. If the heat pump utilizes more than twenty-five (25) gallons of water per minute when it is in operation, surface disposal of the used water is prohibited.

(4) Water Return Wells for Domestic Heat Pump Applications. Water return wells meet the requirements set out in 10 CSR 23 Chapters 1, 2 and 3 concerning casing, casing depth, well seal, borehole, grouting and reporting. The depth of the water return well must not exceed the depth of the water supply well. Water must be returned to the same aquifer it was taken from in the water supply well. A sanitary well seal or a pitless adapter may be used and the water return pipe must extend at least twenty feet (20') below the static water table inside the well casing.

(5) Water Return Wells for Nondomestic Heat Pump Applications. Specifications for water return wells in other than domestic applications will be determined on a case-by-case basis by the division, taking into account the water quality and quantity, geology, hydrology and water usage in the area.

(6) To drill and construct an open-loop heat pump well or a water return well, the driller must have a nonrestricted water well installation permit.

*AUTHORITY: sections 256.606 and 256.626, RSMo 1994.\* Emergency rule filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Original rule filed Aug. 17, 1993, effective March 10, 1994. Amended: Filed Nov. 1, 1995, effective June 30, 1996.*

*\*Original authority: 256.606, RSMo 1991 and 256.626, RSMo 1985, amended 1991.*

#### **10 CSR 23-5.070 Construction Standards for Closed-Loop Heat Pump Systems That Use Refrigerants as the Heat Transfer Fluid**

*PURPOSE: This rule sets standards for heat pump systems that use refrigerants in the closed-loop as the heat transfer fluid.*

(1) Direct Expansion Heat Pump Systems. These types of systems utilize a network of copper tubing or other material buried in a pit or trench. The refrigerant is circulated through the tubing allowing the heat transfer to take place. The ground coil must be installed by a method which prevents leakage of the refrigerant.

(2) Any heat transfer fluids used in a direct expansion heat pump system must be nontoxic and nonhazardous such as HCFC-22, or others that are approved in advance by the division.

(3) Heat pump systems utilizing refrigerants in their closed-loops may be placed into vertical wells if approval is received in advance from the division.

*AUTHORITY: sections 256.606 and 256.626, RSMo Supp. 1991.\* Emergency rule filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Original rule filed Aug. 17, 1993, effective March 10, 1994.*

*\*Original authority: 256.606, RSMo 1991 and 256.626, RSMo 1985, amended 1991.*

#### **10 CSR 23-5.080 Plugging of Heat Pump Wells**

*PURPOSE: This rule sets standards on the proper plugging of wells used in heat pump applications.*

(1) Vertical Closed-Loop Heat Pump Wells. To plug a properly constructed vertical closed-loop heat pump well the following specifications must be met:

(A) Remove all heat transfer fluid from the closed-loop;

(B) Dig down to the top of borehole and cut off the loop pipe. This must be at least three feet (3') below the surface. Pump the remaining loop full of bentonite or cement slurry. Allow the grout to fill the upper one foot (1') of borehole. Fill remaining hole with compacted earth or pavement; and

(C) Submit registration report form and fee to the division within sixty (60) days which documents the proper plugging of the heat pump well. Upon review and approval of the registration report form, a registration number will be sent to the landowner which designates that the well was plugged according to the minimum standards.

(2) Open-Loop Heat Pump Wells. Wells used to supply water for the heat pump and water return wells must be plugged as set out in 10 CSR 23-3.110 Plugging of Wells, and a registration report form submitted as if it were a water supply well.

(3) Plugging Improperly Constructed Heat Pump Wells. When it is determined by the division that a heat pump well is constructed improperly, it must be brought into compliance with the rules or plugged. To plug an



improperly constructed heat pump well, the following specifications must be met:

- (A) Remove all pipes from hole;
- (B) Clean out well bore of loose material;
- (C) Plug well full-length with approved grout; and
- (D) Submit registration report form and fee.

*AUTHORITY: sections 256.606, 256.623 and 256.626, RSMo Supp. 1991.\* Emergency rule filed Nov. 16, 1993, effective Dec. 11, 1993, expired April 9, 1994. Original rule filed Aug. 17, 1993, effective March 10, 1994.*

*\*Original authority: 256.606, RSMo 1991 and 256.623 and 256.626, RSMo 1985, amended 1991.*