

**EPA Region 6 UIC Land Ban Petition Application Guideline**  
**Revised February 2007**

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**EPA Region 6 UIC Land Ban Petition Application Guideline**  
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**Introduction**

The following are general requirements for inclusion with no migration petitions submitted to EPA Region 6 to satisfy the requirements in 40 CFR Part 148. Each no migration demonstration is site specific and may therefore require additional information not included in this general outline. To receive approval, the petitioner must demonstrate, to a reasonable degree of certainty, there will be no migration of hazardous constituents from the injection zone for as long as the waste remains hazardous as per 40 CFR §148.20(a). This time period is defined by 40 CFR §148.20(a)(1)(i) as 10,000 years. Some of the requested information is redundant with the requirements in 40 CFR Part 146 Subpart G, but is required by Part 148 or is used by EPA Region 6 to verify no migration of waste from the injection zone.

**General Outline for EPA Region 6 Land Ban Petition Applications**

**I. Stand Alone Document Demonstrating the No Migration Standard**

- A. Region 6 reviews all aspects of the no migration demonstration during the initial petition review and requests for petition reissuance
  - 1. Incorporate any deficiency responses into one document
    - a. Required for initial petition submissions
    - b. Recommended for applications for reissuance of a petition

**II. Petition Table of Contents**

- A. Each application should include a Master Table of Contents located in the front of Volume 1
  - 1. Listing should also identify the volume number where the topic is located
  - 2. The subsections contained in each section should be included in the Table of Contents
  - 3. A list of tables, figures, and appendices should be included in the Table of Contents
  - 4. Adding a Table of Contents for the specific section or appendix to the front of that specific section or appendix in the document is suggested for expediting the review process
- B. Any appendices containing multiple documents should include a content listing to identify the items if they are not individually labeled or tabbed

**III. Administrative**

- A. Applicant
  - 1. Facility name
  - 2. Well numbers and corresponding UIC permit numbers
  - 3. Addresses
  - 4. Mailing address
  - 5. Facility and well physical address
  - 6. Telephone and facsimile numbers
- B. Facility contact information
  - 1. Person(s) or firm(s) authorized to act on behalf of the applicant during the processing of the application
    - a. Address

- b. Phone numbers
  - c. E-mail address
  - C. Include a signed certification statement as listed in 40 CFR §148.22(a)(4)
    - 1. Must be signed and dated following all final revisions to the document
      - a. Petitioner may wait to submit until the review process is completed
  - D. Summary of past regulatory petition related approvals
  - E. Quality assurance and quality control
    - 1. Describe processes used to verify that proper quality assurance and quality control plans were followed in preparing the petition demonstration - 40 CFR §148.21(a)(4)
      - a. Confirm all referenced tables, figures, appendices, etc., are included in the document
  - F. Elevations
    - 1. Clarify what depth reference elevations are used in the document
      - a. Confirm all depths listed include a reference datum
    - 2. List the plant and well elevations to allow depths to be converted to other reference depths
  - G. Consistently reference specific gravity or density values throughout the petition
    - 1. Use a consistent number of decimal places
      - a. Two decimal places are recommended, but no less than two can be used
    - 2. Always provide a corresponding reference temperature(s)
    - 3. Volume weighted density/specific gravity ranges may be requested by facilities that do not inject a significant volume of immiscible fluid
    - 4. The timeframe for volume weighted density/specific gravity averaging may consist of any of the following:
      - a. Three-whole calendar month
      - b. Running 90 or 91 day (13 week) period
- IV. Updated Adjacent Surface Land Owner Listing - 40 CFR §124.10(c)(4)**
- A. Include the names and mailing addresses of the surface owners of the tracts of land adjacent to the plant boundaries
  - B. Provide a map illustrating the location of the adjacent landowner tracts
  - C. Describe surrounding land usage (farming, industry, residential, etc.)
- V. Petition Application Requests**
- A. Describe the specifics of the petition
    - 1. Identify the specific wastes and waste codes requested - 40 CFR §148.22(a)(1)
    - 2. Specify the well or wells for which the demonstration will be made - 40 CFR §148.22(a)(1)
    - 3. List the specific gravity/density range, injection intervals, end of operations date, injection rates, etc.
    - 4. For a reissuance or modification, specify the requested changes from the approved petition

- B. Clarify if application consists of the containment of waste within the defined injection zone - 40 CFR §148.20(a)(1)(i), chemical fate demonstration - 40 CFR §148.20(a)(1)(ii), or a combination of both
  - 1. If a chemical fate demonstration is requested, additional documentation not covered in this outline will be required to satisfy 40 CFR Part 148

## **VI. Location Maps**

- A. Provide a USGS topographical map (1:24000 scale, if available) indicating the plant boundaries and well location(s)
- B. Provide a simple schematic with a scale or distances listed illustrating the plant boundary and surface and bottomhole well locations of all facility disposal wells
  - 1. Include facility wells completed in other injection intervals (hazardous and non-hazardous)

## **VII. Characteristics of Injection Fluid - 40 CFR §148.22(a)**

- A. Provide a brief summary of the operation or process that generates the injection fluids
- B. Describe the characteristics of the injection wastestream
  - 1. Discuss if the physiochemical nature of the wastestreams are such that reliable predictions can be made to satisfy the standards outlined in 40 CFR §148.20(a)(1)(i) or 40 CFR §148.20(a)(1)(ii)
- C. Include a recent waste analysis
  - 1. Fully describe the chemical and physical characteristics of the subject wastes - 40 CFR §148.22(a)(2)
  - 2. Verify waste codes represent all applicable waste constituents and constituent concentrations do not exceed maximum concentrations used in the demonstration
- D. Describe if waste analysis testing performed is accurate and reproducible - 40 CFR §148.21(a)(1)
- E. Clarify if estimation techniques used were appropriate and if EPA-certified test protocols were used, where available and appropriate - 40 CFR §148.21(a)(2)

## **VIII. Disposal Well**

- A. General
  - 1. Differentiate any plant well numbering system and Class I UIC permit numbers used in the document
  - 2. Provide well location description
  - 3. Include latitude and longitude
    - a. Provide and reference a copy of the well's Class I hazardous waste UIC permit and summarize the permit limitations
  - 4. Provide relevant elevations (ground level (GL) and kelly bushing (KB))
  - 5. Define the KB depths to the Confining Zone, Injection Zone, and Injection Interval in the well
- B. Disposal well design
  - 1. Include a detailed well construction and completion history
    - a. Include sidetracks, abandoned boreholes, or remedial activity

2. Include a wellbore schematic for each well
  - a. Consistently reference depths to the referenced elevation
  - b. For legibility, add expanded detail for complex wellbore construction, if needed
3. Provide daily drilling log or details on well recompletions
  - a. Summarize historical wellwork
4. List the depths and describe the specifics of tubulars, cement, packers, etc used in the completion of the well
5. Provide relevant logs to demonstrate the cement integrity of the well

**IX. Mechanical Integrity Testing - MIT**

- A. Include a copy of the most recent mechanical integrity demonstration (RAT and annulus pressure test) for each well included in the application - 40 CFR §148.20(a)(2)(iv)
  1. Demonstrate mechanical integrity of a well's long string casing, injection tubing, annular seal, and bottomhole cement
  2. Confirm that all injected fluids are entering the approved injection intervals and that no fluids are channeling up out of the injection zone near the wellbore
    - a. Operators may be required to conduct a radioactive tracer survey (RAT) with multiple slug chases between the packer and injection interval to document casing integrity and no loss of fluid above the completed interval

**X. Offset well(s)**

- A. Provide a complete list all facility disposal wells including other well classifications or wells completed in other intervals
- B. Describe all pressure sinks and sources in the same injection zone located within a minimum 10 mile radial distance from the facility
  1. List all offset oil and gas production from the injection interval
    - a. Provide well completion information or general field information
  2. List all offset injection wells completed in the same injection interval (Class I and Class II)
    - a. Provide well completion information and wellbore schematics
  3. Provide a map illustrating the location of sinks and sources
  4. Provide cumulative volumes for the sinks and sources completed in the injection interval
    - a. Include supporting documentation for reported volumes
    - b. Address oil, gas, or water production from producing wells
- C. Support the general area reviewed for pressure sinks or sources based on volumes and reservoir transmissibility
  1. Include any modeling or analytical calculations, if applicable
- D. Identify the source or potential sources of the pressure sink in underpressured injection intervals

**XI. Injection History**

- A. Report and document historical injection into the injection interval to date
  1. Site specific

2. Offset wells
  3. Oil and gas injection, enhanced recovery, or disposal wells
- B. Provide and reference a summary table for the volumes injected into each modeled disposal well, including offset wells
1. List the volumes using the timeframes input into the model
  2. Include a column in cubic feet per day for verification of SWIFT input, if applicable
- C. Based on historical injection, justify the maximum rates modeled during the operational period

**XII. Underground Source of Drinking Water (USDW) Determination**

- A. Define the depth to the lowermost USDW
1. Explain how this depth was determined
  2. Provide logs, equations, and computations, if relevant

**XIII. Regional Geology**

- A. Discuss the regional geology
1. Describe the stratigraphy, depositional environments, tectonic history, and structural geology
    - a. Include a geological stratigraphic column
    - b. Include supporting documentation, i.e. maps, cross-sections, etc.
- B. Discuss the regional hydrogeology
1. Describe aquifers and aquicludes
- C. Seismicity
1. Include a listing of historical seismic activity in the regional area (at least a 100 square mile area around the injection well(s))
    - a. Data should include intensity levels (using an international scale) and distances from the injection facility
    - b. Provide a risk assessment of induced seismicity due to injection activities based on a known induced seismicity formula

**XIV. Local Geology**

- A. Provide a detailed description of the local geology
1. Local geologic area should extend a minimum of 1 mile past the extent of the 10,000 year composite waste plume
- B. Include and reference a type log defining each of the following intervals
1. Confining zone
  2. Injection zone
    - a. Containment interval
    - b. Injection interval
- C. Include an updated commercial structure map on the most applicable reference datum available
1. Compare with the local geologic interpretation and discuss any anomalies

2. Clarify if any geologic features illustrated on the commercial map are relevant to the no migration application
  - a. Address the vertical and horizontal extents of faults, if applicable
- D. Confining Zone
  1. Define a confining zone located above the injection zone - 40 CFR §148.21(b)
  2. Demonstrate the following for the Confining Zone - 40 CFR §148.21(b)(2)
    - a. Thickness
    - b. Porosity
    - c. Permeability
    - d. Areal extent and lateral continuity
- E. Injection Zone
  1. Demonstrate each of the following for the various strata in the injection zone - 40 CFR §148.21(b)(1)
    - a. Thickness
    - b. Porosity
    - c. Permeability
      - (i) Include available core data and core analysis
        - (a) Site specific, offset wells, area wells, or applicable literature references
    - d. Areal extent
    - e. Free of transecting, transmissive faults or fractures to prevent the vertical movement of fluids - 40 CFR §148.20 (b) or (c)
  2. Provide available seismic lines to delineate the local structure of the injection zone if there is a lack of well data at the required depth
  3. Containment Interval
    - a. Identify the strata within the containment interval of the injection zone that will confine fluid movement above the injection interval - 40 CFR §148.20(b)
      - (i) Discuss lithology and mineralogy
    - b. Show the containment interval is free of known of vertically transmissive faults or fractures - 40 CFR §148.20(b)
  4. Injection Interval
    - a. Demonstrate each of the following for the injection interval of the injection zone - 40 CFR §148.21(b)(1)
      - (i) Areal extent and lateral continuity
      - (ii) Provide appropriate structure and isopach maps
    - b. Thickness
      - (i) Base on several criteria, i.e., logs, isopach, cross-sections
  5. Porosity
    - a. Base on several criteria, i.e., logs, core data, core analyses, literature, interference tests, etc.
  6. Permeability
    - a. Include available core data and core analysis
      - (i) Site specific, offset wells, area wells, or applicable literature references
      - (ii) Refer to model input parameters

- b. Hydraulic gradient - 40 CFR §148.21(b)(3)
  - (i) Provide appropriate literature references or calculations
    - (a) Reference gradients from pressure tests, if applicable
- F. Geologic maps
  - 1. Include the following general features on structure, isopach, and base maps
    - a. Map scale should be 1" to 2000'
    - b. Outline the facility and AOR boundaries
    - c. Include appropriate legends, title blocks, and labeling
      - (i) Wells not deep enough to penetrate the mapped datum should be designated as such, e.g., NDE
      - (ii) Wells with no logs available should be designated as such, e.g., NA
    - d. Confirm the unique artificial penetration (AP) numbers are legible
      - (i) Expand portions of the map, if needed, for high well density areas
  - 2. Structure maps should be based on applicable geologic datums
  - 3. Isopach maps should show areal extent and continuity of the specified intervals
  - 4. Illustrate cross-section lines on all maps or include and reference a separate cross-section index map that illustrates the wells included on all cross-sections
- G. Cross-sections
  - 1. Include a minimum of two structural cross-sections perpendicular to each other that extend beyond the 10,000 year waste plume areas
    - a. Include additional mini-cross sections over specific regions to demonstrate specific geologic features, i.e., the extent of a fault
      - (i) Include stratigraphic cross-sections based on a reasonable marker, if correlations are difficult
  - 2. Include the following on each cross-section
    - a. Legend and title block with date last updated
    - b. Small scale map showing the cross-section line
    - c. Top and bottom of applicable intervals, i.e., injection interval, injection zone, confining zones, USDW, etc.
    - d. Document perforations or completion information, if relevant
  - 3. At a minimum, include the well name, artificial penetration (AP) number, operator, well status, total depth, KB elevation for each log posted on the cross-section
  - 4. Scale the cross-section so the depth scale is legible
  - 5. Include and reference a copy of the actual logs included on the cross-section as an appendix
- H. Reservoir dip
  - 1. Clarify if a variable structure or constant dip will be used for the no migration waste plume demonstrations
    - a. Constant dip
      - (i) Justify the average dip angle used in the demonstration
        - (a) Describe or illustrate on a map where and what depths were used
        - (b) List the equations and variables input to calculate the average dip angles

- (ii) Variable dip
  - (a) Clarify what structure map was used for the model input
- I. Provide a sufficient number of well logs to document the structural depths and thicknesses on the structure and isopach maps
  - 1. More data may be required for certain areas if correlations are difficult or unique geologic features exist
- J. Provide fracture gradient calculations and maximum surface pressure limitation

**XV. Geochemistry and Injected Waste Compatibility**

- A. Describe the geochemical conditions of the well site - 40 CFR §148.21(b)(5)
  - 1. Include the physical and chemical characteristics of the injection zone and the formation fluids in the injection zone
- B. Discuss the compatibility of the injected waste with the injection zone
- C. Provide an analysis to demonstrate if the waste will adversely alter the confining capabilities of the injection and confining zones
- D. Discuss compatibility with well construction

**XVI. Model Input Parameters**

- A. Initial and current hydrostatic pressure in the injection zone - 40 CFR §148.21(b)(4)
  - 1. Provide a summary table that lists all historical shut-in pressures for wells completed in the injection interval(s)
    - a. Compare with the initial static pressure assigned for the no migration demonstration
  - 2. Discuss how the initial reservoir pressure was selected based on the available data
    - a. Include all reference data needed to verify selected pressure value
- B. Transmissibility
  - 1. Provide and summarize available historical pressure transient testing, i.e., drill stem tests, falloffs, injectivity, interference, pulse, etc., to support the injection interval transmissibility values used in the no migration demonstrations
    - a. Provide electronic copy of pressure transient tests for site specific and offset wells, if available
    - b. Include summary report, tables, and figures of pressure transient reports
      - (i) Hard copy of recorded pressure and time data not necessary if plot of data is provided
    - c. High and low end transmissibility used in the demonstrations should be reasonably conservative based on available data
- C. Effective net thickness
  - 1. Discuss the selection of a conservative net thickness
    - a. Pressure buildup demonstration
    - b. Plume migration demonstrations
  - 2. Include and reference copies of all criteria on which the net thickness values are based, i.e., logs, isopachs, cross-sections, historical temperature log summary and plots, seismic lines, literature, well tests, RATs, flow profile surveys, etc.

3. Demonstrate how the selected effective net thickness values are conservative based on all available data
  - a. Provide and discuss all historical temperature survey results
    - (i) Include a composite illustration of the temperature logs from the confining zone through the injection zone
    - (ii) Discuss and address any temperature anomalies
  - b. Provide copies of the RAT and flow profile surveys for the past 5 years
    - (i) Discuss how the fill depth and slug chase results were considered in the net thickness determination
- D. Effective permeability
  1. Referencing the transmissibility and effective net thickness discussions, identify a low and high range of permeability values
    - a. Discuss the effective permeability used in the pressure buildup demonstration
    - b. Discuss the effective permeability used in the plume migration demonstrations
  2. Compare selected effective permeability values with available permeability data from pressure transient tests, core data, literature, etc.
  3. Describe how the selected effective permeability values are conservative based on all available data
- E. Reference temperatures
  1. Designate a surface reference temperature for the requested specific gravity or density range of the wastestream
  2. Specify a reservoir temperature of the injection interval and corresponding reference depth
    - a. Include support documentation to verify the reservoir temperature selection, i.e., a plot of the recorded temperatures versus depth from area well logs, temperature surveys, etc.
- F. Density or specific gravity values
  1. Density or specific gravity values should have a minimum of two decimal places consistently used throughout the document, including the modeling
    - a. Two decimal places are recommended
    - b. Precision used in the model should be equivalent to the precision of the requested range
  2. Specific gravity values should have temperature references for both the injectate and reference fluid, e.g., 60°F/60°F
  3. Density values should have a single temperature reference
  4. Provide any calculations used to convert density or specific gravity values at surface conditions to reservoir conditions or vice versa
  5. Provide conversion calculations for input into models, e.g., conversion of density range to lb/ft<sup>3</sup> for input into SWIFT
  6. Formation brine
    - a. Document how the density or specific gravity of the formation brine was selected and state the corresponding reference temperature
    - b. Include copies of all available formation fluid analyses

- c. Explain how equivalent solutions, i.e., NaCl, etc., were determined, if applicable
- 7. Injectate
  - a. State the requested density or specific gravity range of the injectate and corresponding reference temperature(s)
  - b. Include and discuss copies of injectate analyses
  - c. Explain how equivalent solutions, i.e., NaCl, etc., were determined, if applicable
- G. Viscosity values
  - 1. Specify and document the reservoir fluid and injectate viscosities used in the no migration demonstrations
    - a. Explain how equivalent solutions were determined, if applicable
    - b. Include copies of any nomographs, tables, or references used
- H. Compressibilities
  - 1. Document the rock and fluid compressibilities used in the demonstrations
  - 2. Provide appropriate references, interference tests, etc. used to obtain the rock and fluid compressibilities
- I. Porosity
  - 1. Clarify the porosity value used in the demonstration is conservative based on the porosity discussion included in the geology portion of the petition
- J. Concentration reduction factor (CRF)
  - 1. Provide a table listing the CAS number, applicable waste codes, health based limit, maximum concentration, and resulting CRF for each waste constituent, if applicable
  - 2. Use  $1 \times 10^{-12}$  CRF and only include a list the waste constituents with less than 100% concentration
- K. Background gradient
  - 1. Document the regional background gradient in feet/year and direction of movement
    - a. Include any references, calculations, etc.
  - 2. Clarify the background gradients used in the no migration demonstrations
    - a. Do not use a background gradient when modeling plume movement opposing the gradient
    - b. Use the maximum or reasonably conservative value to estimate plume movement in the same direction of the background gradient
- L. Dispersivity
  - 1. State the longitudinal and transverse dispersivities used in the demonstration
  - 2. Provide calculations and appropriate references to support the values selected
- M. Diffusion coefficient
  - 1. Document the diffusion coefficients used to model waste plume movement, if applicable
    - a. Include applicable documentation, references or portion of references to support the assigned free water diffusivity coefficients

2. Provide a table listing the diffusion coefficient for each waste constituent or reasonably conservative value selected for the vertical diffusion demonstration
- N. Include equations, calculations, and reference documents to justify other model input parameters used in the no migration demonstration, i.e., well index, hydraulic conductivity, etc.
1. Include calculations for SWIFT parameters, e.g., RAQ, DMEFF, etc., if applicable

### **XVII. Model Selection**

- A. Keep models as simple as practical
1. Analytical calculations can typically be used for the heavy plume demonstration
  2. Constant dip and constant thickness models are preferred
- B. Describe the numerical and analytical models used in the no migration demonstration
1. Clarify what model is used for which portion of the demonstration
  2. Specify the version of modeling software used, if applicable
- C. Provide verification and validation for any predictive models used in the demonstration - 40 CFR §148.21(a)(3)
1. Include or reference specific documentation
- D. Provide the applicable equations used by any analytical models
- E. Describe how the model is appropriate for the specific site, wastestreams, and injection conditions of the facility operations
- F. Describe how the model was calibrated prior to use for predicting pressure buildup or plume movement
- G. Clarify the solution method used by the model and discuss appropriateness of the method selected, if applicable

### **XVIII. Pressure Buildup Models**

- A. EPA R6 accepts both analytical solution models and SWIFT for pressure buildup modeling
1. If an analytical solution model is submitted for the pressure buildup demonstration:
    - a. Include validation and verification discussion satisfying 40 CFR §148.21(a)(3) and compare the model with another widely accepted analytical model such as PanSystem or hand calculations such as those provided in SPE Monograph 5 Appendix C
    - b. If the petition pressure buildup demonstration involves fault boundaries, the validation and verification information should address this as well
  2. If the SWIFT model is used, include one of the following:
    - a. Include a SWIFT sensitivity run with a larger grid to confirm the pressure buildup demonstration result is reasonable or doesn't change with a larger grid. This would address grid limit concerns
    - b. Include a supporting analytical calculation to confirm SWIFT results

Note: The sensitivity model run(s) (SWIFT and/or analytical calculations) would also address requirements for sensitivity analysis under 40 CFR §148.21(a)(6)

**XIX. No Migration Demonstration**

- A. Clarify all timeframes contained in the demonstration
- B. Initialization period, if applicable
  - 1. Run the model for a sufficient time to show model stability
  - 2. Demonstrate no background gradient is generated by the model input for zero background gradient modeling
  - 3. Verify the appropriate background gradient exists for the heavy plume model
  - 4. Demonstrate background velocities present prior to injection in variable structure or variable thickness models
    - a. Illustrate or map the magnitude background velocities
- C. Historical period
  - 1. Include all historical injection from wells completed in the modeled injection interval
  - 2. Include historical production, if applicable
- D. Modeled operational life
- E. Run the model for the requested operational life
  - 1. Use the maximum requested injection rates
    - a. 10,000 year demonstrations
  - 2. Buoyant plume
    - a. Do not include an opposing regional background gradient to maximize plume movement
  - 3. Heavy plume
    - a. Include background gradient, if in the downdip direction
    - b. Facilities that can demonstrate the lack of potential for future oil and gas development in the vicinity of the injection well facility, possibly because of the geologic environment, e.g., lack of structural trap, in the area of the injection well facility, Region 6 requires a minimum 200 year heavy waste plume demonstration that incorporates an appropriate background gradient (based on an EPA headquarters policy that oil and gas production will cease within 200 years)
      - (i) Wells located within the heavy plume and outside the cone of influence, lack a mechanism for waste to migrate vertically upward making the shorter demonstration sufficient to demonstrate that waste will not migrate vertically upward in an abandoned well for 10,000 years
- F. Modeled boundaries
  - 1. Clarify what type of outer boundary conditions were implemented on all sides of the model grids and document the appropriateness of the selected boundary
  - 2. Describe any no flow boundaries input in the model and what the boundaries represent, i.e., symmetry, fault, pinch-out, etc.

- a. Describe how no flow boundaries were input in the model
  - (i) Document the number and location of image wells was sufficient, if applicable
- G. Document the modeled injection rates for all wells included in demonstration, including production wells, if appropriate
  1. Historical period
    - a. Provide quarterly injection reports for most recent five year history
    - b. Provide annual injection volumes for six plus year well histories
    - c. More rigorous injection data can be provided and used, if desired
  2. Requested operational period
  3. Area or offset well rates during post-operational period, if applicable
- H. Address any area geologic features
  1. Clarify what geologic features are included in each demonstration (pressure buildup, plume, etc.)
  2. Clarify how the geologic features are included (image wells, no flow boundary, etc)
  3. Provide sufficient documentation for exclusion of any geologic feature, i.e., analytical calculation showing no impact on pressure buildup
- I. Document the assumptions used in low density waste plume demonstration:
  1. Low-end of the density range compared to formation fluid
  2. Exclusion of a background gradient to maximize updip plume movement
- J. Document the assumptions used in the high density waste plume demonstration
  1. High-end of density range compared to formation fluid
  2. Use of a background gradient to maximize the downdip movement
- K. Document the assumptions used in the vertical diffusion demonstration
  1. Describe the depth, within the injection interval, used as the starting point for the maximum vertical diffusion movement
  2. Specify the maximum vertical movement used for the no migration demonstration into intact strata and the appropriate mud-filled or brine-filled wellbore
  3. Describe the method selected to determine the maximum vertical diffusion
    - a. List the vertical diffusion distances for each waste constituent and calculations used for determining the maximum vertical diffusion distances
    - b. Justify use of a worst case constituent and how it was applied in the demonstration
    - c. Apply a 1000' vertical diffusion distance and do not document the free water diffusivity coefficient for the various constituents
      - (i) Facilities with brine-filled artificial penetrations (APs) may be required to make additional diffusion calculations if specific circumstances exist
- L. Results - Clarify the movement of waste from injection operations will not result in the vertical movement of waste from the injection zone or laterally within the injection zone to a point of discharge or interface with a USDW
  1. Total vertical movement of waste from injection operations and diffusion
  2. Document the maximum pressure buildup

- M. Document any convergence or material balance errors and demonstrate values are insignificant
- N. Document the model grid and cell sizes are appropriate for the demonstration
  - 1. Discuss how the grid orientation, cell size, etc was selected

**XX. Plots**

- A. Document the plotting program used to illustrate model results accurately depicts the model output and does not distort the plume boundary
- B. Provide an outline of the operational plume, updip and downdip plumes overlain on a structure map of the injection interval
  - 1. Include an outline or overlay of the grid area

**XXI. Sensitivity Analysis**

- A. Perform a sensitivity analysis in order to determine the effect of uncertainties associated with model parameters - 40 CFR §148.21(a)(6); Preamble to the July 26, 1988, Final Rule for 40 CFR Part 148, page 28129
  - 1. Identify areas where uncertainty is present in the geologic description or reservoir characterization
  - 2. Determine a likely range of values and perform sensitivity analyses which would address the impact of the uncertainty, if applicable
    - a. Assign reasonably conservative parameters to maximize the pressure buildup and waste movement using appropriate estimation techniques and testing protocols - 40 CFR §148.21(a)(2)

**XXII. Cone of Influence**

- A. Define the minimum cone of influence (COI) - 40 CFR §148.20(a)(2)(i)
  - 1. Include all COI equations, calculations, and values assigned to the various equation parameters
    - a. Demonstrate the assigned values are conservative, i.e., brine-filled wells, mud-filled wells, minimum mud weight
  - 2. Overlay the COI contour from the maximum pressure buildup demonstration on a map to illustrate which wells are located within COI, if applicable
    - a. Pressure contour frequency should allow reviewer to easily estimate the maximum pressure buildup at each artificial penetration location, if the pressure buildup information is not available elsewhere in the document
- B. Skeleton type wellbore schematics should be provided for each artificial penetration (AP) located within the cone of influence. The wellbore schematics should include:
  - 1. Unique AP number
  - 2. Well name and number
  - 3. Well location
  - 4. Name of operator
  - 5. Well status
  - 6. Basic well drilling and construction information critical to the well's evaluation, e.g., total depth, hole sizes, casing size and setting depth, cementing information, plug depths, mud weights, etc.

7. Operators may also include additional information to expedite the review. This data may include:
  - a. Reference depths
  - b. Well elevation
  - c. Regulatory interval depths: USDW, confining zone, injection zone, and injection interval

### **XXIII. Area of Review (AOR)**

- A. Describe the AOR used in the demonstration - 40 CFR §148.20(a)(2)(i)
  1. At a minimum, use a 2-mile radius around the well(s)
  2. Specify a larger AOR based on the COI, if necessary
- B. Locate and identify all artificial penetrations (APs) located within the larger of the COI or AOR using acceptable protocol - 40 CFR §148.20(a)(2)(ii)
  1. Use a unique numbering system so there are no duplicate AP numbers
  2. Include sidetracked or abandoned wellbores within a current completion or plugged well
- C. Ascertain the condition of all APs located within the larger of the COI or AOR that penetrate the injection zone or confining zone - 40 CFR §148.20(a)(2)(ii)
  1. Use acceptable protocol
  2. Identify all wells within the AOR and assign a unique AP numbering system
    - a. Document any water wells that penetrate the confining zone
  3. Verify the well status of any active or temporarily abandoned wells
- D. Demonstrate that all wells are properly constructed or plugged to prevent the migration of waste from the injection zone based on the maximum pressure buildup demonstration - 40 CFR §148.20(a)(2)(i)-(iii)
- E. Provide sufficient well records that are grouped and separated for each well (Tabulation of AP well data is not required)
  1. Level of documentation required for each well is dependent on whether the well penetrates the confining zone, injection zone, or injection interval and if the well is located within the cone of influence or waste plume
  2. Documentation may include scout tickets, log headers, etc. to verify the location of plugs, casing, mud weights, etc.
  3. Identify all wells that are not constructed or plugged to satisfy the no migration standard
    - a. Provide corrective action plan for any such wells - 40 CFR §148.20(a)(2)(iii)
  4. Use tabs to separate blocks of well records to facilitate record review

### **XXIV. Waste Plume Boundaries**

- A. Locate and identify all artificial penetrations (APs) located within the 10,000 year waste plumes (Tabulation of AP well data is not required)
  1. Overlay the composite plume on a base map
  2. Use a unique AP numbering system so there are no duplicate AP numbers
  3. Include sidetracked or abandoned wellbores within a current completion or plugged well
- B. Ascertain the condition of all APs located within the 10,000 year waste plumes that

- penetrate the injection zone
1. Use acceptable protocol
  2. All wells outside the AOR, but within the composite plume boundaries should be identified and assigned a unique AP number
  3. Verify the well status of any active or temporarily abandoned wells
- C. Demonstrate these wells are properly plugged or constructed so that no waste would migrate from the injection zone due to buoyancy or molecular diffusion in an AP - 40 CFR §148.20(a)(1)
1. Brine filled wellbores do not pass the no migration standard if located within a buoyant plume
- D. Provide sufficient well records that are grouped and separated for each well (AP summary tables are not required)
1. Level of documentation required for each well is dependent on whether the well penetrates the confining zone, injection zone, or injection interval and if the well is located within the cone of influence or waste plume
  2. Documentation may include scout tickets, log headers, etc. to verify the location of plugs, casing, mud weights, etc.
  3. Identify all wells that are not constructed or plugged to satisfy the no migration standard
    - a. Provide corrective action plan for any such wells - 40 CFR §148.20(a)(2)(iii)
  4. Use tabs to separate blocks of well records to facilitate record review

#### **XXV. Implementation and Compliance Section**

- A. Describe documentation in place at the facility that allows verification of compliance with no migration petition approval conditions
- B. Note: Documentation maintained for UIC permit compliance may not be sufficient for the no migration petition compliance
1. Provide a simple wastestream flow diagram
    - a. Illustrate sampling points and metering equipment
  2. Wastestream density or specific gravity compliance
    - a. Describe how the facility will comply with petition requested range
      - (i) Records maintained at the facility should list the density/specific gravity range at the referenced temperature
    - b. Describe any temperature compensation or correction methods, if applicable
      - (i) Include an example of the temperature correction process if completed manually
  3. Describe the instrument and measurement methodology
  4. List the measuring and metering equipment calibration schedule

#### **Use of Reasonably Conservative Values**

The “reasonably conservative values” term is discussed in the Preamble to the July 26, 1988, Final Rule for 40 CFR Part 148, page 28129. Region 6 allows the use of reasonably conservative or estimated values when site specific data is unavailable or limited - 40 CFR §148.21(a)(5). The demonstration should include supporting information from literature or other sources to support these values. The reviewers will establish suitably conservative values,

resulting in the protection of human health and the environment, during the petition evaluation. Sensitivity analysis or selection of some values may be more sharply defined because of the availability of site specific or field data.

### **Modification**

The regulations contained in 40 CFR §148.20(f) allow for modification to an approved exemption to include additional waste or wastes. The modification application must demonstrate the requested wastes behave hydraulically and chemically in a manner similar to previously included wastes and will not interfere with the containment capability of the injection zone.

### **Reissuance**

The regulations contained in 40 CFR §148.20(e) allow for reissuance of an approved exemption to modify any conditions placed on the exemption. The reissuance demonstration must also meet the no migration criteria.

### **Public Notice**

EPA will issue a public notice - 40 CFR §148.22(b), with a minimum 45 day public comment period required by 40 CFR §124.10(b)(1) for all proposed decisions. Should EPA decide to hold a public hearing, a minimum 30 day public notice will be given prior to the hearing - 40 CFR §124.10(b)(2).

### **Final Decision**

EPA will publish final decisions in the *Federal Register* as required by 40 CFR §148.22(b).

### **Petition Conditions**

In accordance with 40 CFR §148.20(d)(2), Region 6 typically requires certain annual monitoring placed as a condition of petition approval.