Minimizing and Managing Potential Impacts of Injection-Induced Seismicity from Class II Disposal Wells: Practical Approaches

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Purpose

Provides the UIC Director with tools for minimizing and managing induced seismicity on a site-specific basis, using available Director discretionary authority.

The authority used to address potential USDW risks from seismic events could include:

- Loss of disposal well mechanical integrity;
- Impact to various types of existing wells;
- Changes in USDW water level or turbidity;
- USDW contamination resulting from fluid movement through faults, wellbore damage, or earthquake-damaged surface sources.

National Technical Workgroup Tasks

1. Compare parameters identified as most applicable to induced seismicity with the technical parameters collected under current regulations.
2. Prepare a decision model.
3. Assess applicability of pressure transient testing and/or pressure monitoring techniques.
4. Summarize lessons learned from case studies.
5. Recommend measurements or monitoring techniques for higher risk areas.
6. Analyze applicability of conclusions to other well classes.
7. Recommend specific areas for further research needed.

Critical Components

Pressure buildup

- An increase in the formation pore pressure from disposal activities.

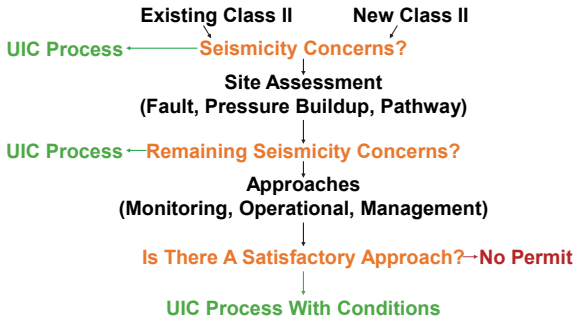
Faults of Concern

- Optimally oriented for movement, and under critical stress.
- Sufficient size for movement to potentially cause a significant earthquake.
- May be a single fault or a zone of multiple faults and fractures.

Pathway

- A permeable avenue (matrix or fracture permeability) allowing the pore pressure increase to reach the fault.

Decision Thought Process



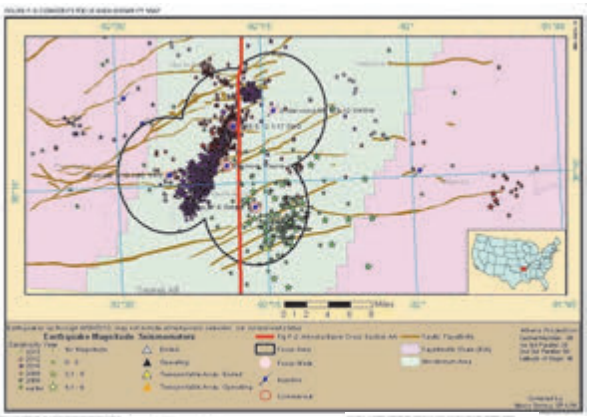
Work Flow and Action Plan

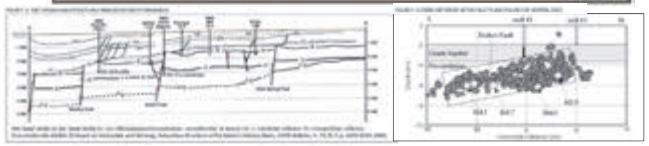
Step 1	Step 2	Step 3	Step 4
			
Collect necessary data	GIS Mapping and Analysis	Can the potential be mitigated?	Act in a timely fashion

Multi-Disciplinary Site Assessment

Information Needed	Source
Regional and Local Seismicity	USGS or state agency catalog; event accuracy, seismometer spacing
Detailed Well Information	Permit and other well files, including daily disposal volumes and pressures
Geologic Setting	Maps, cross-sections, permit application, seismic surveys, publications
Reservoir Characterization	Core analysis, well tests, well logs, hydraulic fracture results, publications
Reservoir Pressure	Static pressure: gauge or fluid level
Flow Character	Analysis or modeling
Pathway	Analysis or test results
Stress Direction	Borehole breakout, production logs

Site Example

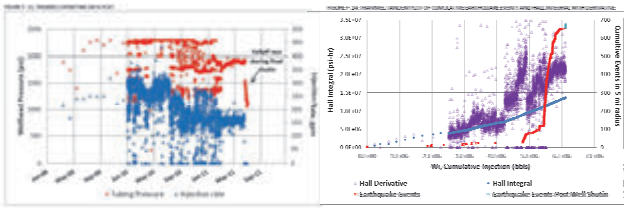




The Director acquired additional site information, requested action from operators, and prohibited disposal operations. Specific examples include:

- Increased monitoring and reporting requirements for disposal well operators to provide additional operational data for reservoir analysis.
- Required one well to install a seismic monitoring array prior to disposal as an initial permit condition.
- Required plugging or temporary shutin of suspect disposal wells linked to injection-induced seismicity while investigating or interpreting additional data.
- Defined a moratorium area prohibiting Class II disposal wells within a defined high risk area of seismic activity.

Petroleum Engineering Analysis



Report Conclusions

- Be proactive rather than requiring definitive proof.
- Utilize multi-disciplinary approaches.
- Understand that pressure can be transmitted miles through fractures.
- Apply established engineering tools using high quality data.