Quarterly Report – Public Page

Date of Report: *January 10, 2025*
Contract Number: *693JK32310001POTA*
Prepared for: *DOT - Pipeline And Hazardous Materials Safety Administration*
Project Title: *A Comprehensive Study of Barriers for Underground Natural Gas Storage Wells*
Prepared by: *Pennsylvania State University*
Contact Information: *Arash Dahi Taleghani, Arash.Dahi@psu.edu , 814-865-5421*
For quarterly period ending: December *31, 2024*

1: Items Completed During this Quarterly Period:

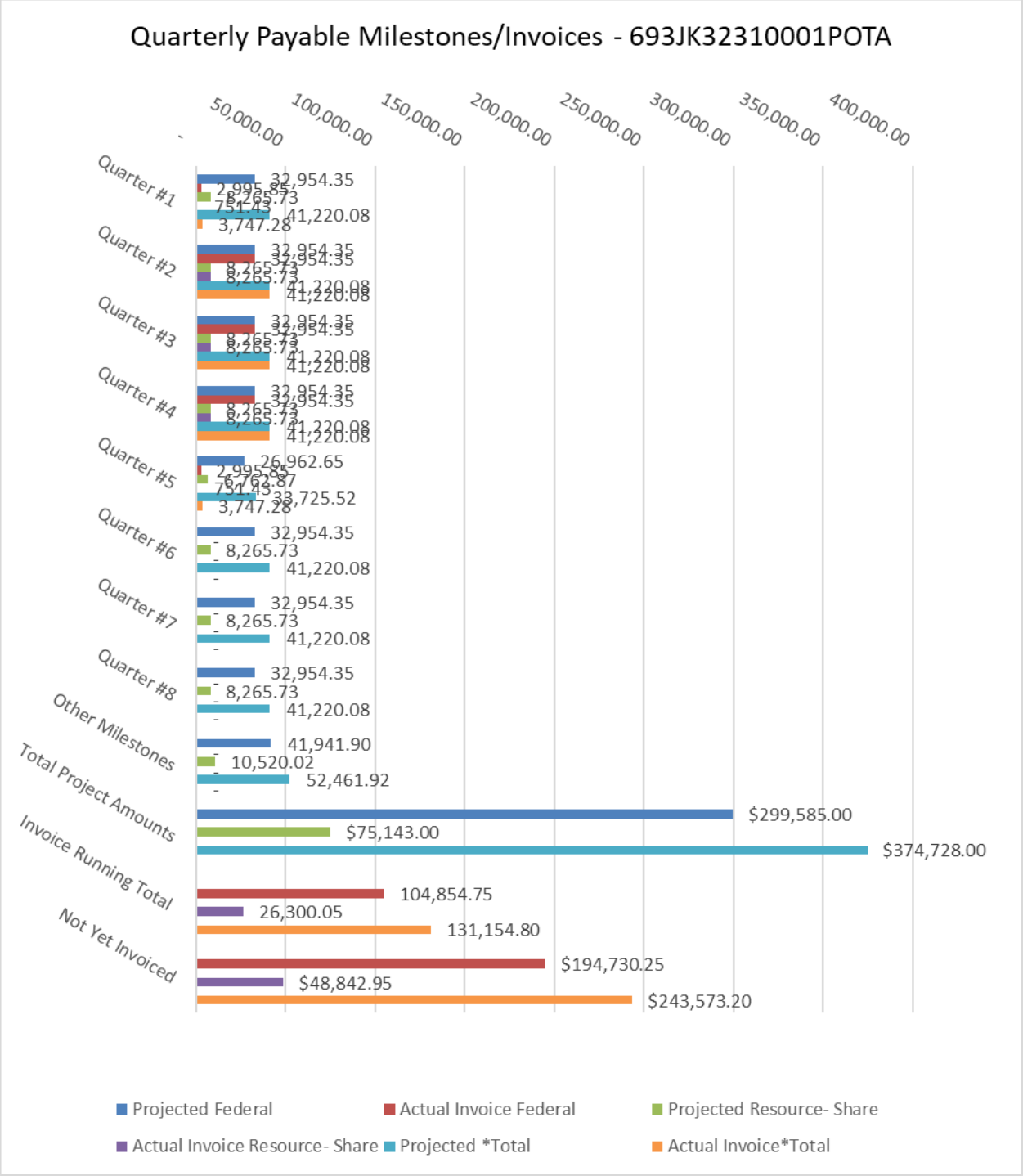
Item #	*Task #*	*Activity/Deliverable*	*Title*	*Federal Cost*	*Cost Share*
7	***4***	**Develop workflows for assessment and testing novel tools and methods for detecting micro-annulus in wells**	**Workflow for designing and testing a novel tool for micro-annulus detection in cemented wells**	**$29,958.50**	***$7,514.30***
10	**5**	**5th Quarterly Status Report**	**Submit 5th quarterly report**	**$ 2,995.85**	***$ 751.43***

2: Items Not-Completed During this Quarterly Period:

The first deliverable is due after the second quarter of the project. The rest of the project is moving according to the plans.

Item #	*Task #*	*Activity/Deliverable*	*Title*	*Federal Cost*	*Cost Share*
12	**5**	**6th Quarterly Status Report**	**Submit 6th quarterly report**	***$2,995.85***	***$751.43***

3: Project Financial Tracking During this Quarterly Period



4: Project Technical Status –

During this quarter, our research focused on evaluating cement integrity and microannulus behavior in underground gas storage wells, with particular emphasis on understanding leakage pathways and detection methods. Key findings and progress include:

The study identified that wellbore cement integrity is critical for both underground gas storage (UGS) and plug and abandonment (P&A) operations. Our research revealed that microannuli as small as 10-15 μm can serve as significant pathways for gas movement, with their formation influenced by factors such as thermal contraction, stress reduction at interfaces, and cement hydration processes.

We made significant progress in understanding detection methodologies, analyzing various techniques including:

- Ultrasonic imaging tools (USIT) for high-resolution detection of wet and dry micro-annuli
- Advanced cement bond logs (CBL) for evaluating acoustic wave attenuation
- X-ray computed tomography (CT) for detailed analysis of microannuli geometry
- Thermal imaging and infrared logging for identifying active leaks

The research demonstrated that microannuli exhibit fracture-like, non-uniform geometries, requiring more sophisticated modeling approaches than previously used. We developed improved analytical models incorporating both viscous and inertial flow components, moving beyond traditional Darcy flow calculations to better represent real conditions.

A key finding was that hydraulic apertures often differ from mechanical apertures due to surface roughness and flow path tortuosity, necessitating more complex modeling approaches. The study also highlighted the challenges of two-phase flow within microannuli, particularly relevant for gas storage applications where phase transitions can significantly impact leakage behavior.

Looking ahead, we identify the need for further research in:

- Developing more accurate models that account for dynamic changes in microannuli geometry
- Improving understanding of two-phase flow behavior in microannuli
- Enhancing detection and monitoring technologies for early identification of potential leakage pathways
- Standardizing best practices for cement integrity assessment globally

5: Project Schedule –

In the fifth quarter of the project, everything is on track. The scheduled deliverable is going to be submitted to USDOT. The team is working to deliver the next item by the end of this quarter.