

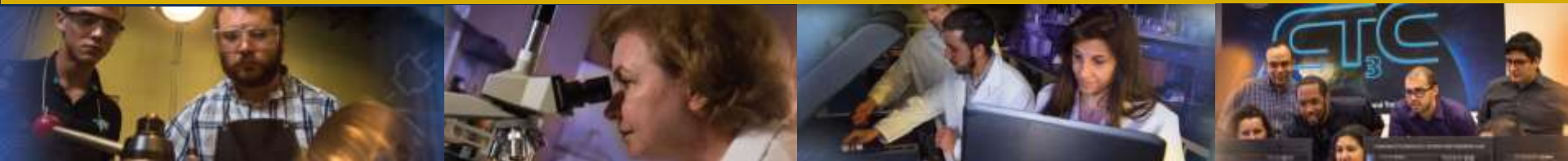


# Asynchronous Pulsing System

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# Background

## Background:

- Approximately 56 million gallons of HLW is currently being stored at Hanford. The transfer of waste to DSTs or the WTP create potential for plugging which can delay project milestones and be hazardous and expensive to repair.
- Industry call (~ 2002) - a number of pipeline unplugging technologies were evaluated. Two technologies were identified as having potential and brought back for further testing and evaluation in 2008/2009.
- FIU began developing our own technologies based on lessons learned – 1) Peristaltic Crawler, 2) **Asynchronous Pulsing System**

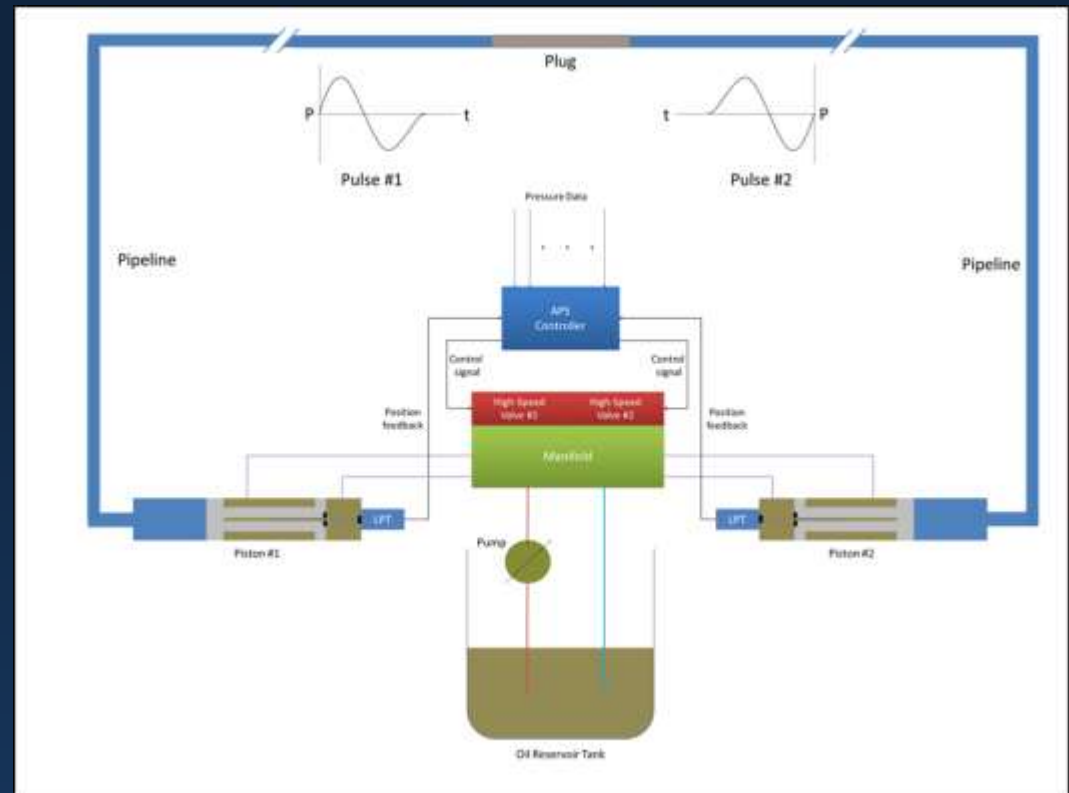


# Project Description

Principle: pressure pulses created asynchronously from both sides of the plug to capitalize on dynamic loads

## Previous Research:

- Designed and procured system
- Set up bench scale test – 3 in diameter pipeline with 300 psi limit, determined system operational parameters and validated operational principles
- Conducted additional studies on effects of entrained air – how to mitigate



Initial bench scale set up



# Project Description

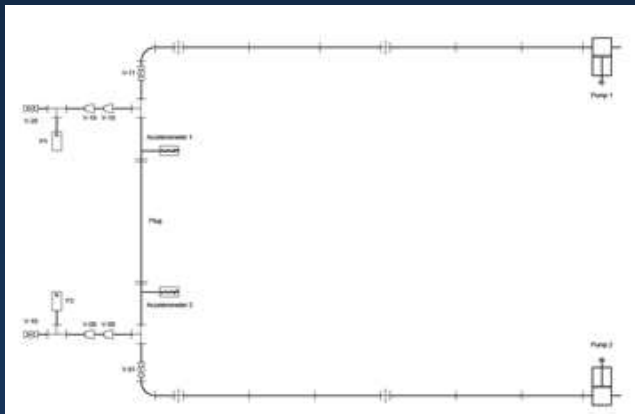
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## Previous Testing:

Evaluate the asynchronous pulsing system on an engineering scale

## Testbed

135 ft. of 3" threaded steel pipes on each side of plug (0.25% slope)  
instrumented with pressure transducers, accelerometers and thermocouples







# Project Description

## Plug Manufacturing:

- Two plugs were created in each batch
  - 1 for Blowout Testing
  - 1 for Unplugging Testing
- Manufacturing Process:
  - Kaolin-Plaster plugs mimic the physical behavior of HLW plugs

Material	Amount (in kg)	Process	Time (in min.)
Water	6	Pouring	$\infty$
Kaolin	5.14	Pouring and mixing	2
Plaster of Paris	6	Pouring	2
		Mixing	3

- Plugs are wet cured for a 24 hour period before being transferred to their respected test



# Project Description

## Plug Blowout Testing:

- Plug Blowout testing was performed after 24 hours of curing to determine the quality of each batch
  - Pressure was steadily increased until the failure point
  - Only plugs that would hold a pressure of 400psi+ were considered ready to be placed on the pipeline
  - Unplugging testing was then performed on plugs that were proven to hold 400psi+





# Previous Results

- Conducted parametric testing – static pressure, pulse amplitude, pulse frequency, % air
- From parametric testing – use optimal system parameters to unplug 3ft kaolin /plaster of Paris plugs

Pulse Wave Type	Pulse Frequency (Hz)	Unplugged (Y/N)	Average Pressure Amplitude (PSI)	Cycling Time (sec)
Triangle	1.0	Yes	192.5	1973
Triangle	2.0	Yes	96.5	1403
Triangle	3.0	Yes	92.5	5273
Square	1.0	Yes	162.5	2708
Square	2.0	Yes	123.5	2172
Square	3.0	Yes	97	3297
Sine	1.0	Yes	180.5	1816
Sine	2.0	Yes	106	2557
Sine	3.0	Yes	82.5	2721

## Unplugging Trials



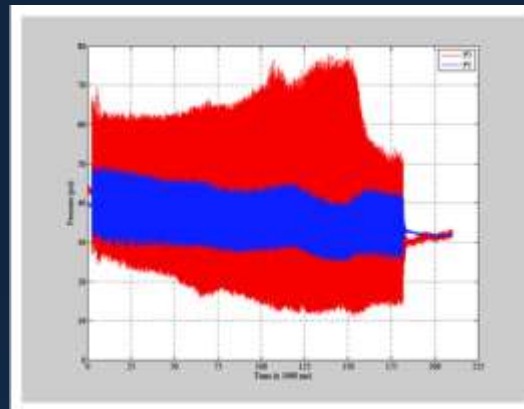
# Previous Results

## Previous Results:

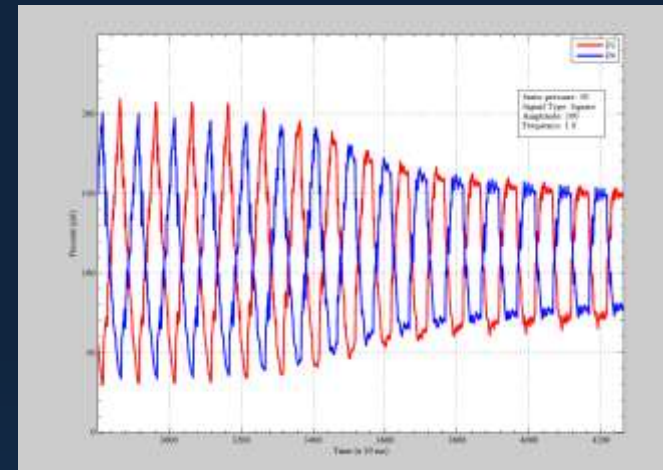
### Unplugging of 3-ft kaolin-plaster plugs



Plug prior to testing



Successful unplugging trial –  
complete breach



Pressure response to dislodged plug



Dislodged plug





# Current Testing

## Air Entrainment Plug Testing

Air Quantity	Trail	Unplugged (Y/N)	Time Elapsed (Hrs)	Amplitude (A)	Frequency (Hz)	Wave Type
No Air	1	Y	4	100/150	1,2,3	Square
	2	Y	3	150	1	Square
	3	Y	6	150	1	Square
Half-Stroke	1	Y	4.5	150	1	Sine
	2	Y	8	150	1	Square
	3	Y	5.5	150	1	Square
Full-Stroke	1	Y	9.5	150	1	Square
	2	Y	10	150	1	Square

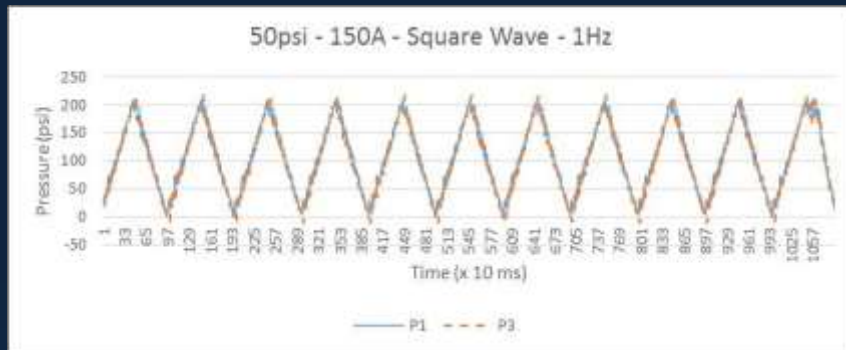
\*All tests were performed at a baseline static pressure of 50 psi.



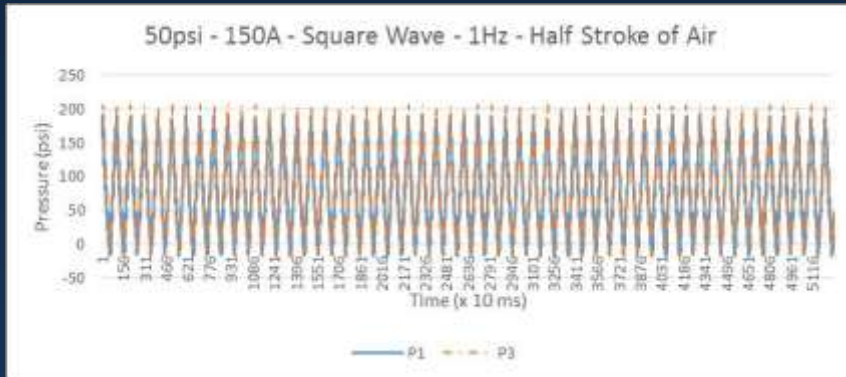
# Current Data

Air Entrainment Plug Testing – P1 → P3

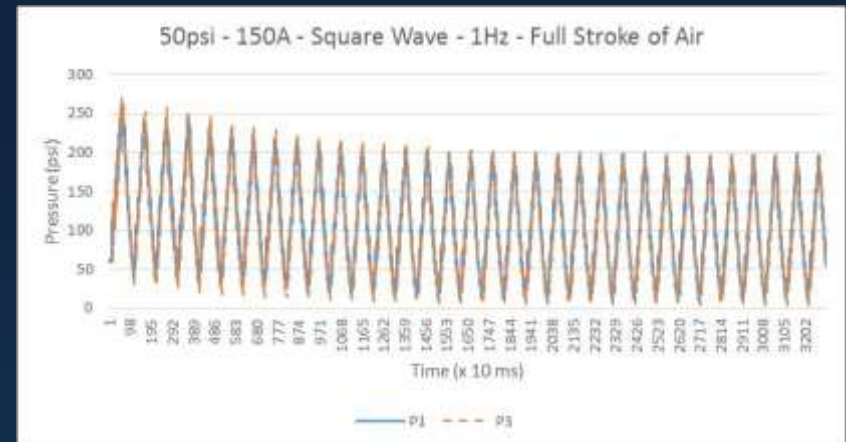
## Sample Data:



No Air in System – 3 hours



Half Stroke of Air in System – 5.5 hours



Full Stroke of Air in System – 9.5 hours

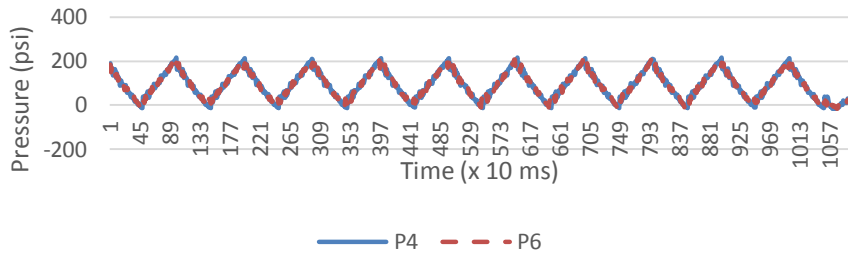


# Current Data

Air Entrainment Plug Testing – P6 → P4

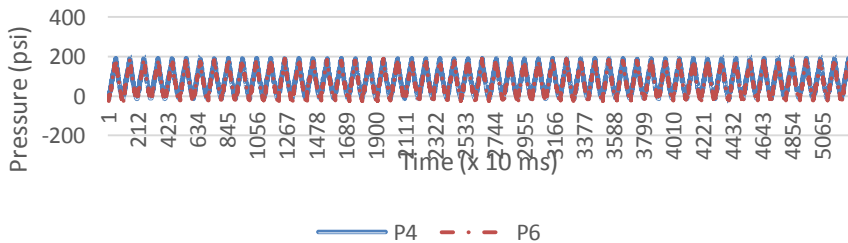
## Sample Data:

50psi - 150A - Square Wave - 1Hz



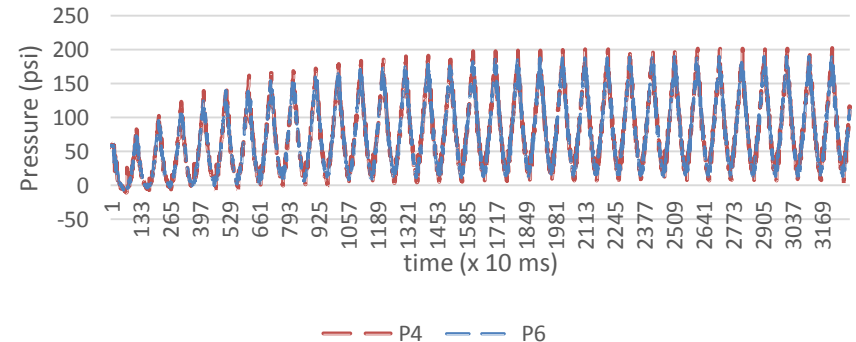
No Air in System – 3 hours

50psi - 150A - Square Wave - 1Hz - Half Stroke of Air



Half Stroke of Air in System – 5.5 hours

50psi - 150A - Square Wave - 1Hz - Full Stroke of Air



Full Stroke of Air in System – 9.5 hours

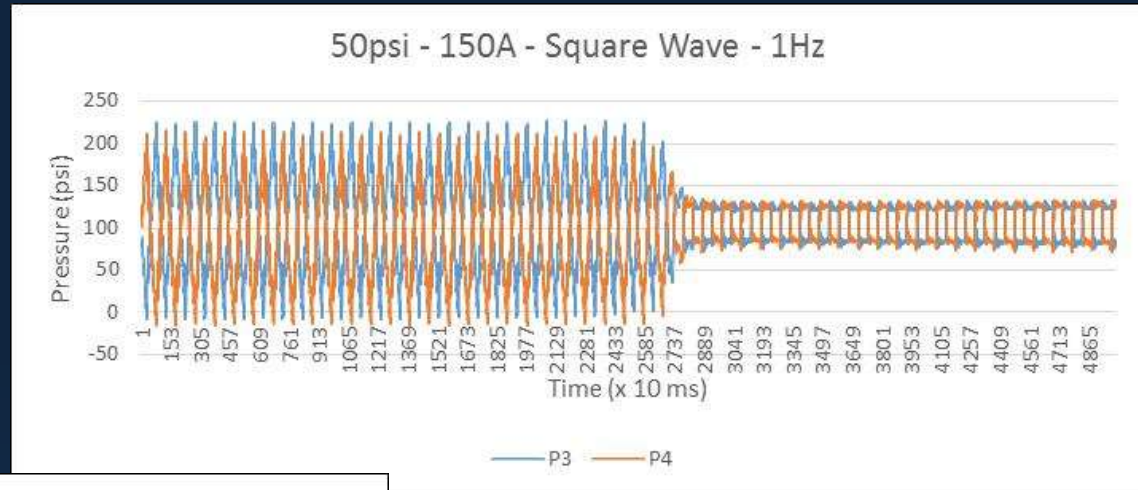


# Current Data

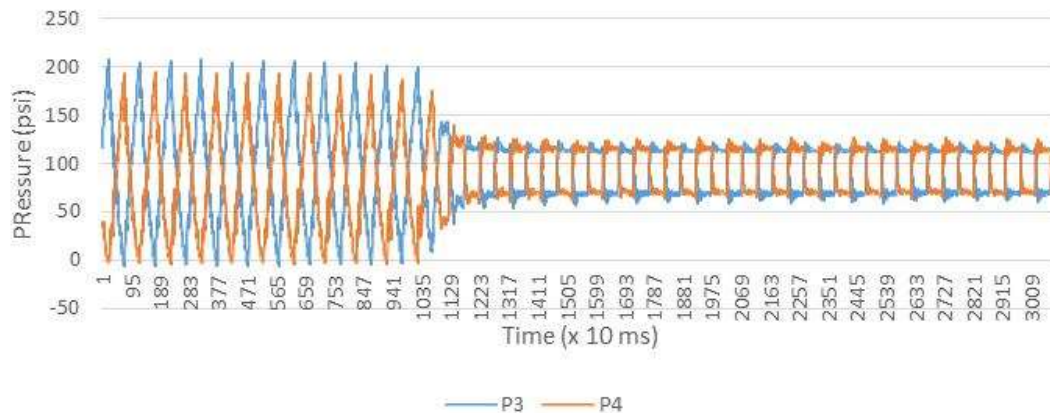
Air Entrainment Plug Testing – P3 → P4

## Unplugging Data:

No Air in System – 3 hours



50psi - 150A - Square wave - 1Hz - Half Stroke of Air



Half Stroke of Air in System – 5.5 hours





# Path Forward

- Complete Data Analysis – for all tests
- Complete reports – milestone documents
- Investigate opportunities for onsite testing



# Acknowledgements

- Mentors
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