# Electronic Detonator Precision & Signature Hole Analysis Provide New Alternatives for Pipeline Construction

## Project Summary

### DIGISHOT® ELECTRONIC DETONATORS AND SHA GIVE PIPELINE CONTRACTORS A NEW OPTION

Utilization of Signature Hole Analysis (SHA) combined with DigiShot® electronic detonators demonstrated how close proximity blasting can be achieved even with very conservative vibration limitations. Reduced vibration effects, by using timing sequences that result in destructive interference, can significantly improve productivity and trench advance by eliminating decking and increasing borehole spacing's to reduce drilling and loading cycle times. This resulted in linear foot advancements each day.

## Background

### NEW PIPELINE CONSTRUCTION REQUIRES A DELICATE TOUCH WIHTOUT SACRIFICING PRODUCTIVITY

The construction of a new 24-inch crude oil pipeline next to an existing pipeline posed several risks for the contractor. Not only was the allowable vibration limit at the existing pipeline very conservative, but residential houses were only 60 feet away. The nearby neighbors were not happy that blasting for a new pipeline was disrupting their daily lives.

Traditional blasting using pyrotechnic detonators was planned for this project, but areas of significant rock posed problems with regard to maintaining vibration levels within project specifications of 2.00 ips for surface structures and 4.0 ips for buried utilities.

In order to meet these regulations, conservative blast designs using multiple decks and reduced hole spacing was employed, but this resulted in a reduction in the linear feet excavated per day.

## Project Goals

### MAXIMIZING PRODUCTIVITY WHILE REDUCING VIBRATION ACHIVED WITH PRECISION DETONATORS AND PROPER TIMING

Dyno Nobel proposed the use of signature waveform analysis to develop site-specific timing sequences that would allow for the use of single column blast designs even in deep holes. Continuous real time SHA analysis would insure that changes in geology would be evaluated and proper timing modifications would insure maximum destructive interference between holes for reduced off site effects.

By utilizing electronic detonators and SHA timing, larger charge weights could be initiated without risk of vibration issues. Larger explosive charge weights per hole and the efficiency of precision hole detonation would allow for expanded drill patterns, reducing the number of holes required per mile of trench.

By eliminating decking, borehole loading could be simplified. With no need to deck between charges in each hole, the time required to load each hole would be dramatically reduced, again increasing linear trench excavation per day.

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## Technology Applied

### DIGISHOT FLEXIBILITY ALLOWS EASY CHANGES TO MEET SHA TIMING RESULTS

To determine optimum delay firing times for vibration control, single hole test shots were detonated and recorded along the pipeline as excavation continued. Signature waveform analysis was done in the field to insure that any changes required by geological variations could be incorporated into the next production blast.

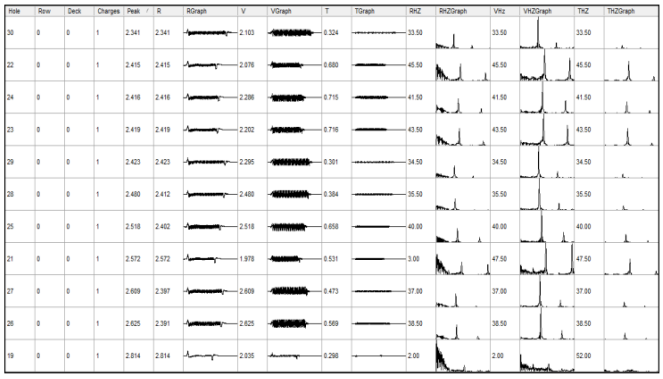
DigiShot electronic detonators insured precise timing for each hole, allowing the interaction of seismic energy produced by each detonation to actively cancel transient vibration effects.

The Dyno Nobel blast team applied the alternative designs using the DigiShot system to insure precise firing times. Accurate timing sequences allowed for a methodical evaluation of each blast.

## Value Added

### REDUCED VIBRATION WITH HIGHER CHARGE WEIGHTS CONFIRM THAT ELECTRONIC DETONATION CAN PROVIDE PIPELINE PROJECTS WITH A VIABE ALTERNATIVE

The use of signature hole analysis is not a new concept for vibration control. However, it was not until the application of electronic detonators that the full ability to actively reduce peak particle velocity was realized.



The use of signature hole analysis has traditionally been limited to mine and quarry applications. Now, by combining the ability to rapidly analyze single hole blast data with the programmability of the DigiShot system, this technology can be easily applied to pipeline construction, providing a new means of maintaining compliance when faced with strict vibration standards for both adjacent buried utilities as well as nearby surface structures.

Test blasts documented peak particle velocity values of 1.75 ips for 8 pound charge weights with traditional non-electronic detonators at a distance of 20 feet. SHA and DigiShot detonators recorded lower peak particle velocity (1.64 ips) at twice the charge weight per blast hole (16 pounds) at the same distance. Additionally, the number of blast holes loaded and initiated per day remained around 1300, allowing the project to stay on schedule and budget.

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