A New Look at Determining the Sensitivity Levels of Oilfield Shaped Charges

Authored by: James Kinsey

Presented by: Eric Ni

China International Perforating Symposium 2014
CIPS-14-005
Abstract Summary

- The test series was prompted by multiple customer complaints received regarding misfired or low-ordered guns where the absence of detonating cord clips was determined to be the cause of the failure.

- Research the effects on charge performance and sensitivity by moving the detonating cord away from the charge at differing distances.

- The current method used by manufacturers is to add playing cards to the charge case ears and transfer from the detonating cord to the charge through the cards.

- Compare the effects using the current method (playing cards) and the real world scenario (air gap).
Methods for Spacing

- Playing Card Testing
- Air Gap Testing
Test Series

- For the test series 80 grain RDX LS XHV cord was used

- One consistent charge used throughout testing
  - Average Standard deviation in QC concrete is
    - ~4.9% for penetration
    - ~5.4% for hole size

- Data Measurements
  - Aluminum bars were probed and measured with a depth gauge for total penetration
  - If full penetration could not be probed, bars were cut to retrieve jet
Test Method

- **Data Analysis**
  - Neyer SenTest software utilizes the Bruceton test method for a statistical analysis of the data
  - The Bruceton method uses a fire/no-fire criterion to determine a distance where a 50% success rate is achieved

- **Test Considerations**
  - Compressible cards with numerous laminations can have a negative effect in large gap testing
  - Shockwave dynamic theory is critical based upon the impedance of materials and interfaces
  - The air gap setup reduces user variability whereas the playing card testing has shown to be user dependent
Playing Card Test Results - Basic Analysis

• Performance Analysis
  ▫ There was no statistical significance in the performance variations seen in hole size or penetration.
  ▫ The standard variation for performance of this charge with no playing cards is comparable to the variation seen in the playing card testing.

• Sensitivity Analysis
  ▫ Using the Neyer SenTest software it was determined with 99.9% confidence that at 19 playing cards (0.190") you will successfully initiate 50% of the time.
Air Gap Test Results - Basic Analysis

- Performance Analysis
  - There was no statistical significance in the performance variations seen in hole size or penetration.
  - The standard variation for performance of this charge with no air gap is comparable to the variation seen in the air gap testing.

- Sensitivity Analysis
  - Using the Neyer SenTest software, finding a distance of 50% initiation could not be determined at 99.9% confidence when using an air gap.
Testing Conclusions

• After testing it was concluded that the maximum distance of initiation (cord distance from charge case) is further using an air gap than playing cards.

• However, the consistency of initiation and associated cord distance is difficult to determine in an air gap. Throughout the air gap testing a 99.9% confidence factor could not be achieved.
Recommendations

The following recommendations are based on analysis of the data gathered during the test series:

- When loading guns, always use manufacturers loading recommendations to attach detonating cord to charge. This will drastically improve the consistency of initiation.

- More testing needs to be conducted to solidify the air gap testing method to provide a higher confidence factor amongst a variety of charges.

- If a higher confidence factor and reliability level can be obtained, the industry standard (playing cards) may need to be re-evaluated to examine a real world sensitivity requirement.
Future Testing and Considerations

- Testing results have the potential to be charge type, explosive type, and detonating cord type specific

- Consider testing in a solid spacer material where laminations do not exist

- Testing of other explosive types to determine effects of, and comparison to, alternate explosive sensitivity testing methods

- Testing in full system scenarios (guns) to determine real world sensitivity levels