HALLIBURTON

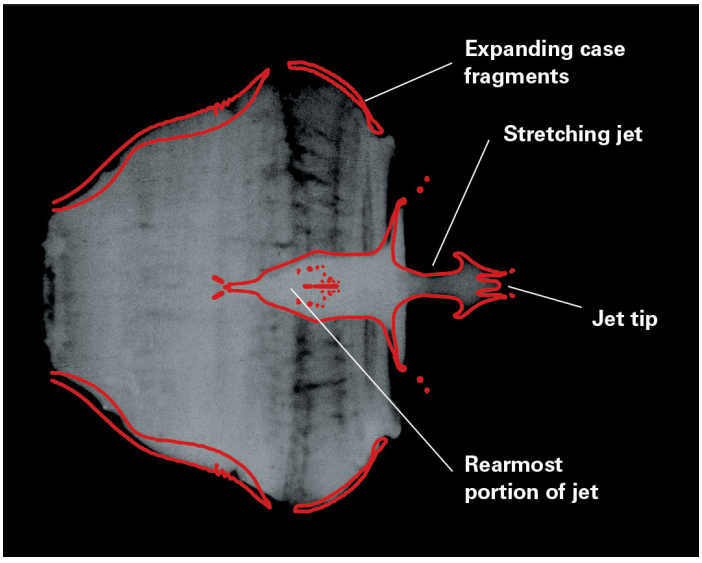
PERFORATING | GUN SYSTEMS

Maxim® shaped charge

Sand control perforating systems tailored for multiple casing string applications

The completion of wells in unconsolidated formations generally requires some form of sand control or gravel packing for flow assurance. For a cased and perforated sand control completion, the perforating strategy typically calls for perforations with the largest possible exit hole in the casing with as high a shot density (spf) as possible. The large casing exit hole improves the likelihood of placing sand or gravel into the perforation tunnel, and the higher spf increases the effective flow area resulting in lower pressure drop across the completion during production.

As completion targets in deepwater environments go deeper, drilling challenges are compounded, forcing operators in many cases to set the casing shoe point higher than planned to safely reach deeper primary targets. Unfortunately, this scenario results in secondary pay zones that have multiple strings of casing across portions or the entire length of the pay zone.



Flash x-ray and hydro-code simulation of a shaped charge during detonation sequence.

This situation presents a serious technical challenge because the typical big-hole (BH) perforating system cannot efficiently penetrate multiple casing strings and still produce an adequate casing exit hole. The results using conventional BH perforating systems in the past yielded a large exit hole in the first casing string and a very small exit hole in the second casing string with minimal formation penetration.

Revolutionary shaped charge liner design meets the challenge

Shaped charge design engineers at the Halliburton Jet Research Center (JRC®) facility unleashed the power of Maxim® shaped charges by using hydro-code modeling software and flash x-ray imaging to develop a proprietary shaped charge liner that optimizes the casing exit-hole size when penetrating multiple casing strings.

Existing dual-string technology

Maxim® dual-string technology

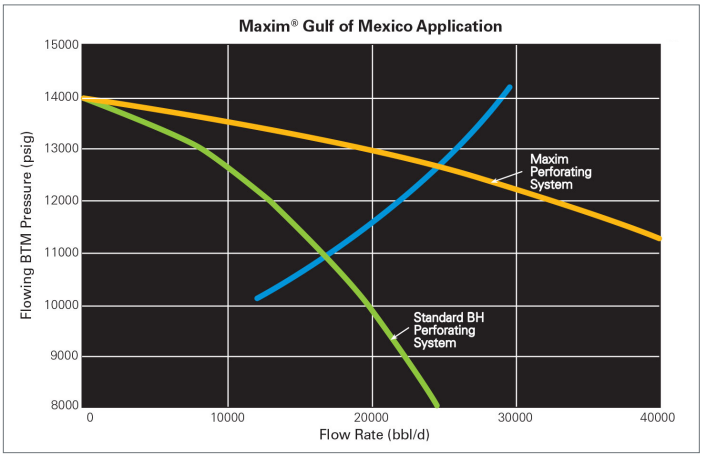
The effectiveness of the Maxim shaped charge concept was demonstrated with the development of a 5-in. 8-spf 47-g charge for a completion scenario with 7⅝-in. 47.1 lb/ft P-110 and 9⅝-in. 47 lb/ft P-110 casing. A standard 5-in. 12-spf 28-g BH gun system was tested under the completion configuration described resulting in a casing exit-hole size of 0.28 in.

The Maxim perforating system resulted in a casing exit-hole size of 0.66 in. with an impressive formation penetration of 6.0 in. These results show a significant 136% improvement in casing exit-hole size and 270% improvement in flow area on a per ft basis.

Drilling sidetrack option eliminated in deepwater completion

A major operator in the Gulf of Mexico faced the dilemma of drilling a sidetrack with significant reserves behind 7⅝-in. and 9⅝-in. casing strings in multiple deepwater completions. Project economics dictated flow assurance through efficient gravel packing of the uphole reserves. Intervention to perform well cleanouts due to sand production were not acceptable, and choking the production due to poor perforating performance was equally undesirable. Evaluation of the current BH perforating systems on the market at the time pointed to an expensive sidetrack option to fully recover the reserves due to the multiple casing strings.

The Maxim shaped charge met and exceeded the operators requirement for a minimum exit-hole size of 0.5 in. allowing this operator to fully recover the booked reserves without the expensive sidetrack of the primary wellbore. The inflow performance relationship (IPR) curves demonstrate the value proposition that the Maxim perforating system can deliver when operators face completions with reserves behind multiple strings of casing. In this case, with a flowing tubing pressure of 1,200 psi, oil production is increased from 17,000 to 24,000 BOPD, representing a significant acceleration in cash flow.



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Tailored to meet specific completion challenges

The Maxim perforating system has been optimized to meet several challenging completion configurations as shown below.

Maxim® charge performance data

GUN OD	SPF	EXPLOSIVE LOAD	INNER CASING	EXIT HOLE	OUTER CASING	EXIT HOLE	PENETRATION
4.63 in.	5	56.5 g	7¾ 46 lb C-110	0.73 in.	9⅞ in. 68.1 lb C-110	0.66 in.	7.95 in.
5.00 in.	8	47 g	7⅝ 47.1 lb P-110	0.75 in.	9⅝ 47 lb L-80	0.66 in.	6.00 in.
5.75 in.	10	56.6 g	8⅝ 60.8 lb P-110	0.78 in.	11¾ 65 lb P-110	0.63 in.	7.50 in.
7.0 in.	14	56.6 g	9⅝ 47 lb L-80	0.61 in.	13⅜ 72 lb P-110	0.68 in.	8.77 in.

For more information, contact your local Halliburton representative or visit us on the web at www.halliburton.com