

Proppant-delivered  
production assurance

Build effective, long-term  
production assurance  
into every well

Assure production and increase recovery  
while reducing production maintenance costs

**CARBO**  
Production. Enhanced.

# Protect your well and production while reducing costs

The GUARD family of proppant-delivered production assurance technologies brings you a highly efficient, effective and simple way to protect your well from production issues.

## Protect your well in a simple treatment while you frac

CARBO can help you maintain your optimal production rates and maximize ultimate recovery, efficiently and cost-effectively, by preventing flow assurance issues and protecting asset integrity to safeguard your production.

## Safeguard the entire production system

Our GUARD family of technologies enables our proppant to act as an advanced chemical delivery system. So now you can deliver highly effective production assurance treatments directly into the fracture—with no impact on fracture conductivity. With one simple treatment during fracturing operations, our technology provides long-term protection from the tip of your fracture throughout your entire production system.

## Reduce production maintenance costs

Each production assurance treatment can be engineered to last for the effective life of the well based on anticipated production profiles. Our technologies significantly reduce production maintenance requirements and costs, avoid workovers and eliminate the potential for catastrophic production system failures.

## Address multiple issues in a single treatment

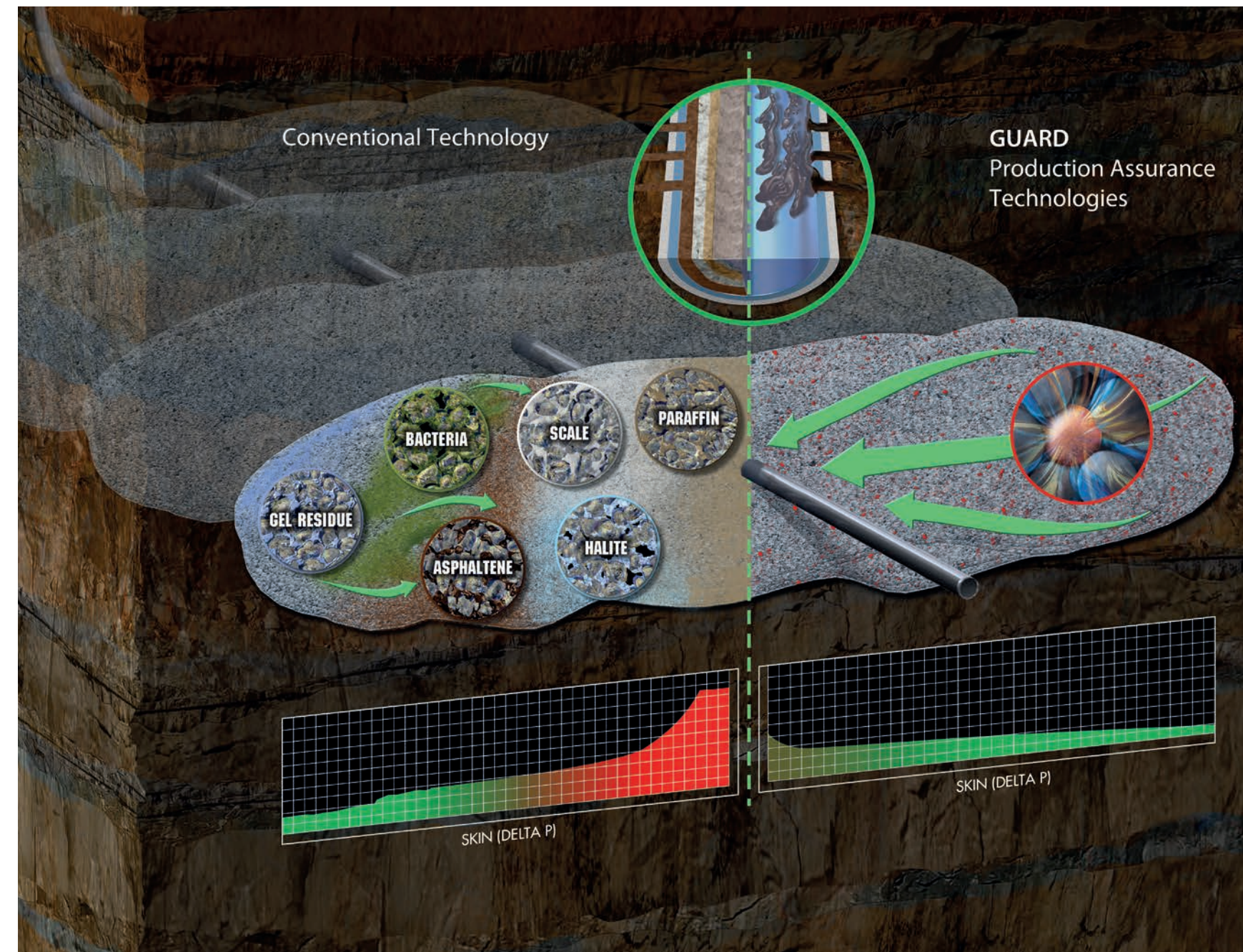
We are developing and commercializing technologies to deliver effective treatments to address common production issues. By blending multiple GUARD proppant-delivered production assurance technologies, we are able to create treatments to protect wells against any number of production issues in a single treatment.

## More efficient and effective than alternative treatments

Our unique proppant-delivered technologies outperform other production assurance treatments which can be inefficient, expensive and required to be repeated due to their short effective periods:

- Particulate chemical carriers placed in the fracture have high initial chemical release due to disintegration upon the application of closure stress
- Initial and periodic chemical squeezes have high chemical flowback, which makes inhibition short-lived; the treatment needs to be repeated frequently to maintain the required minimum inhibitor concentration (MIC), resulting in high chemical consumption and costs
- Continuous chemical injection has a higher chemical consumption than proppant-delivered technologies and the injection system needs to be maintained
- Water injection and hot oil injection treatments have high ongoing logistical, environmental and operational costs

Scale and other production issues can quickly and significantly impair flow in your fractures and production system



# Controlled chemical release for effective long-term protection

By placing the production assurance chemicals where they are needed and avoiding chemical washout, GUARD technology provides effective, long-term protection while reducing chemical consumption and treatment costs.

## A unique, innovative technology

The CARBO portfolio of proppant-delivered production assurance technologies is unique in the industry. The GUARD family has been engineered by creating a proppant with a uniformly distributed, interconnected porosity that is infused with production chemicals.

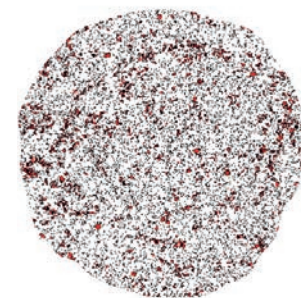
## Engineered for effective chemical delivery and strength

An engineered, uniformly distributed, interconnected porosity maintains the critical strength of the proppant to ensure there is no impact on fracture conductivity, while also making the proppant an effective chemical delivery mechanism. As the chemical is infused in a uniform manner throughout the porosity of the proppant pellet, you can place larger volumes of chemical in the fracture than you would experience with surface adhesion.

## Controlled chemical release

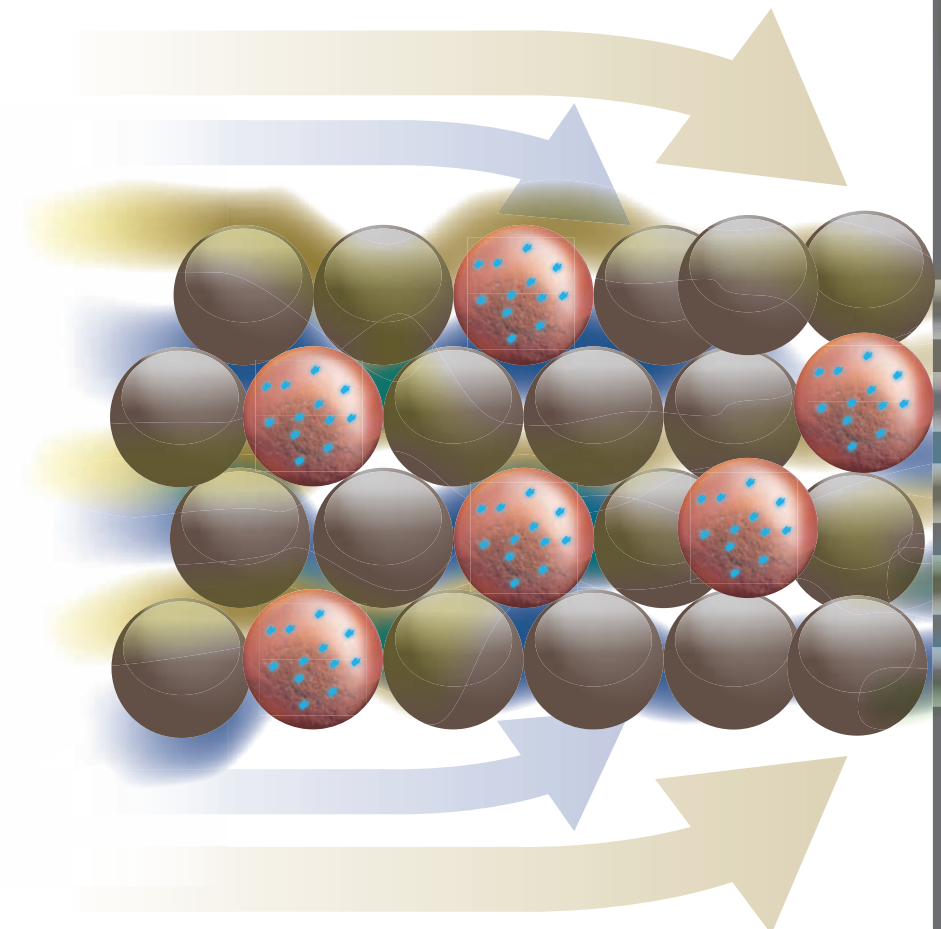
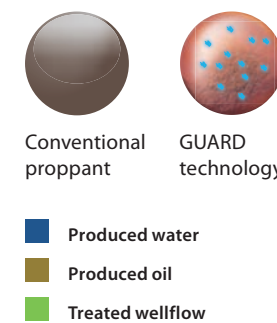
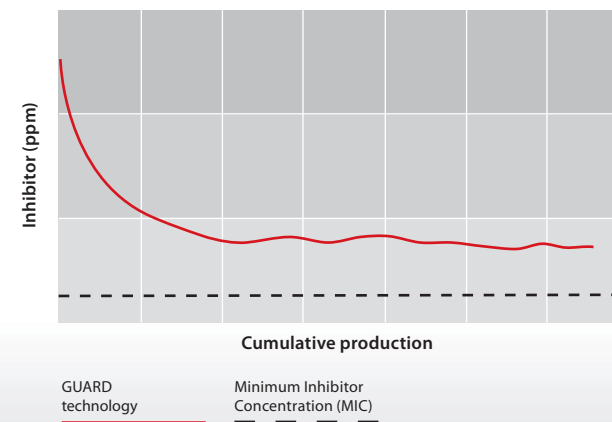
GUARD technology features a controlled release technology that ensures a predictable release of the infused chemical in the well. The controlled release technology provides a significant reduction in initial chemical washout and a controlled release, resulting in an extended elution profile. The technology also provides improved fracture fluid compatibility.

Our proppant-delivered production assurance technology can be blended onsite, or delivered pre-blended with specified proppant for the well



**Proppant cross section showing infused chemical**  
The high affinity and increased contact between the chemistry and the proppant grain slows elution

**Field study of elution control with GUARD technology**  
Example of elution control from a deployment of GUARD technology

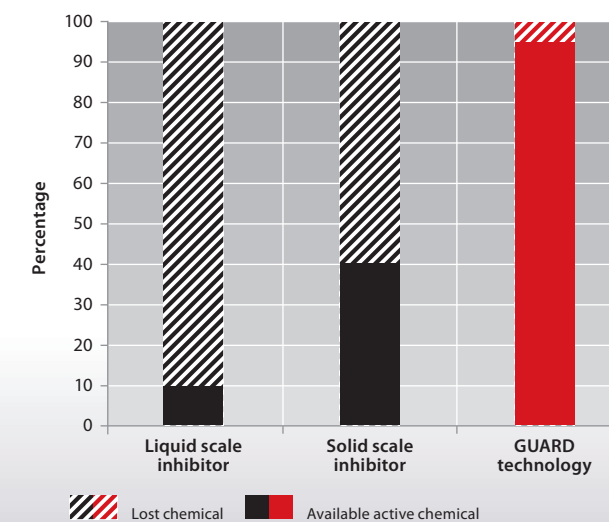


Production assurance chemicals infused within the proppant are released into the fracture only on contact with specified production fluids or other engineered activation mechanisms to deliver highly efficient, long-lasting production assurance.

## Reduce chemical consumption and waste

GUARD technology is a highly efficient chemical delivery system that places up to 95% of the chemicals in the fracture and delivers a predictable release. As a result, we can design effective treatments that can cost-effectively assure production for the effective life of the well.

Percent of effective chemical available after placement

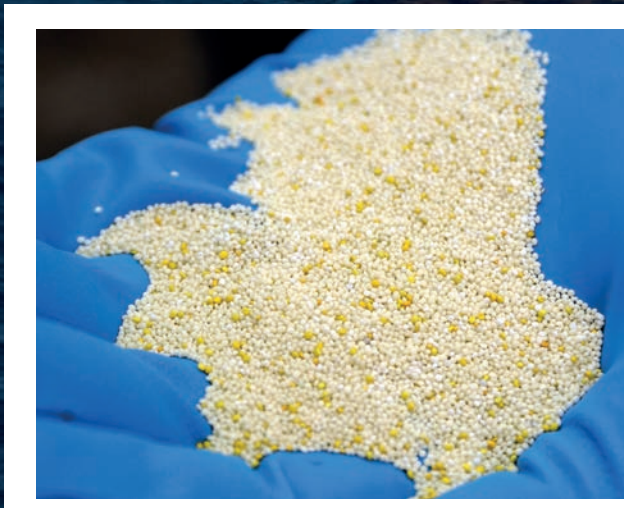
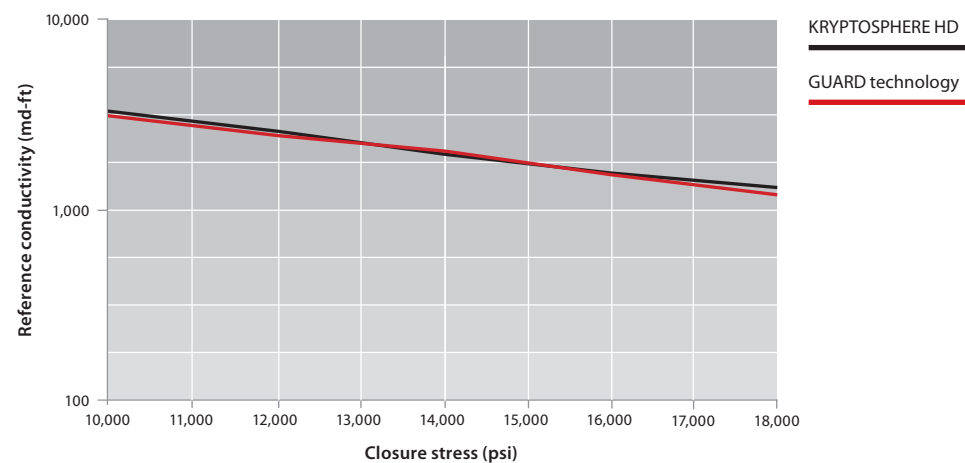


# No impact on fracture conductivity or integrity

Our GUARD technologies are proppant-delivered so they have no impact on fracture conductivity, and they have the strength and durability to avoid the creation of fines.

Our proppant-delivered production assurance technologies serve as both a chemical delivery system and a proppant, which means they have no impact on fracture conductivity or durability. The uniform distribution of the engineered porosity of the proppant ensures that it retains its strength while avoiding excessive fines that restrict or block hydrocarbon flow spaces: a risk associated with lower strength particulate-based carriers.

Conductivity results KRYPTOSPHERE with GUARD technology



## Protecting conductivity and assuring long-term production in the Gulf of Mexico

A tailored solution engineered with KRYPTOSPHERE® HD ultra-conductive, high-density ceramic proppant and SCALEGUARD® proppant-delivered scale-inhibiting technology was chosen to maximize both conductivity and the treatment of scale for a major operators' deepwater Gulf of Mexico well.

# A complete service for total production assurance

Our Production Services team designs, supervises and monitors each production assurance treatment to ensure that it provides long-lasting, cost-effective protection for your well.

## Custom treatment design

Our engineering team designs each production assurance treatment based on the unique characteristics of your reservoir, predicted well flow and your production objectives. Our team can perform an analysis of production fluids beginning at the wellsite to determine the production issues that exist and identify the level of risk to production.

Each treatment is custom engineered by selecting the active chemical and concentration, the base proppant substrate, and the ratio of each GUARD technology to be blended. Our engineers design the optimal placement of GUARD technology within the fracture to ensure the most efficient inhibition treatment.

## Treatment supervision to safeguard execution

Our wellsite supervision team oversees any blending of our proppant technologies required onsite with the specified proppant, and the pumping of the job to ensure that each treatment is executed as designed.

In addition to the supervision of treatment execution, CARBO provides any required onsite blending equipment. We can also provide proppant pre-blended with GUARD technology at the specified ratio directly to your wellsite.

## Field sampling and treatment evaluation

Our field sampling team performs regular onsite sampling and conducts an analysis of flowback fluids throughout the life of the treatment to confirm that levels are within specification.

CARBO uses a network of laboratories for performing sample analysis to validate the success of each treatment. These laboratories are strategically located to support all major unconventional plays.



## CARBO Production Services include:

- Treatment design
- Treatment supervision
- Field sampling and laboratory testing
- Post-treatment evaluation and validation

## Integrated services to enhance production

In addition to production assurance treatment, our Production Services team undertakes the design, supervision, monitoring and evaluation for our proppant-delivered flow enhancement and proppant-delivered fracture evaluation services.

Our innovative portfolio of proppant-delivered production enhancement services provides you with new, more effective and efficient ways to assure production, increase flow and understand your fractures—enabling you to optimize your production and development strategy.

Our team collaborates closely with advisors from our STRATAGEN® fracture consulting services business to provide you with an integrated fracture-related service to *design, build and optimize the frac*®, which helps you to enhance production, increase recovery and lower total F&D cost per BOE.



# Proven assurance in onshore and offshore wells

GUARD technology has been proven to be successful in preventing production issues in key unconventional plays across the US, and employed in deepwater Gulf of Mexico.



CARBO® is an industry-leading production enhancement company that integrates technologies and intellectual capital to design, build and optimize fractures.

Our products and services enable clients to increase production and recovery for the life of the well by identifying the optimal balance of contact and conductivity for the reservoir, and building it efficiently to lower total finding and development costs per BOE.

To order any of the products from the GUARD family of proppant-delivered production assurance technologies please call +1 800 551 3247 or complete a contact form [carboceramics.com/contact](http://carboceramics.com/contact)

[carboceramics.com](http://carboceramics.com)

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