



# BaraShield<sup>®</sup>-663 LCM Standard Field Application Procedure

**Prepared for:** All Customers

**Prepared by:** Sharath Savari, Donald L. Whitfill

**Submitted by:** Halliburton

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## 1. Overview

BaraShield®-663 lost circulation material (LCM) is a proprietary, engineered particulate formulation designed to rapidly seal pores and fractures of up to approximately 500 microns. With a proprietary particle size distribution and special particle properties, BaraShield-663 LCM can tightly seal a highly permeable formation or pack a fracture entrance rapidly with a thin layer of sealing particulates. This rapid, high efficiency sealing can be quantified by its small/controlled spurt loss and fluid loss and can be measured with an Aloxite disc or a slotted disc in an industry-standard Permeability Plugging Apparatus (PPA).

To stabilize unconsolidated sand or highly micro-fractured shale or coal formations while drilling, BaraShield-663 LCM, after being premixed in mud, can instantaneously seal the pores or micro-fractures of various sizes being drilled and exposed by a bit. A tight seal is required to allow the wellbore pressure overbalance acting on the wellbore wall to stabilize the wellbore and maintain a gauged hole.

Drilling naturally fractured and highly porous formations may experience seepage mud losses. BaraShield-663 LCM can be used to pretreat the mud system to prevent the seepage losses while drilling.

Drilling through a depleted formation or drilling an offshore deepwater well with narrow mud-weight windows, induced mud losses and induced fractures are often experienced. The behavior of an induced fracture is predictable. Such a wellbore can be stabilized by securely sealing the incipient induced fractures. To seal an induced fracture, it is critical that the spurt into the fracture is small and the seal forms instantaneously and further prevent fracture propagation. The patent pending “STRESS-SHIELD Engineering Method (SEM)” is a process to design and ensure the fluid spurt invasion is well controlled with BaraShield-663 or BaraShield-664 LCMs to prevent induced mud losses.

BaraShield-663 LCM has no built-in suspending capability and should always be mixed with fluid with some suspending capability, preferably drilling fluid, which already has a viscosifier in its formulation.

BaraShield-663 LCM is compatible with all conventional WBM, OBM or SBM. **Since BaraShield-663 LCM is an “Engineered, Composite Solution” (one sack), it should be used on its own and is NOT recommended to supplement any other conventional LCM like BARACARB®, WALL-NUT® or BAROFIBRE®. Only, BaraLock®-666 LCM is the recommended Supplemental LCM for BaraShield-663 LCM. Consult with Technical Manager/Regional Technical Manager and if needed Global Technical Advisors for potential suggestions on other supplemental LCM if any.**

### Recommended BaraShield-663 LCM Applications

BaraShield-663 LCM may be applied for wellbore stabilization through controlling a low invasion into unconsolidated sand, fractured coal formations or micro-fractured shale formations. Furthermore, BaraShield-663 LCM may also be applied for prevention of mud losses in pores, natural fractures or induced fractures. Typically, the concentration of BaraShield-663 LCM is around 10 ppb as background in the continuous drilling fluid for plugging pores. If

sealing fractures may be needed, the concentration can be raised to around 20~40 ppb to minimize the spurt into fractures. These concentrations can be adjusted based on the observation at the rig site. For induced fractures, the “STRESS-SHIELD Engineering Method” (SEM) can be applied to determine the treating concentration of BaraShield-663 LCM by integrating rock mechanical properties and the fluid spurt control.

- 1) Pretreatment applications to stabilize a wellbore:
  - a. Add to active fluid in circulation to drill unstable formations.
- 2) Pretreatment applications to prevent drilling fluid losses:
  - a. Add to active fluid in circulation to drill naturally fractured or highly permeable formations.
- 3) Prevent induced losses and strengthen a wellbore with concentrations of BaraShield-663 defined by SEM
  - a. Add to active fluid in circulation to drill low fracture gradient/weak wellbores.
  - b. Add to pill fluid to be pumped to cover a depleted interval, and to pressurize the wellbore to the strength required.
  - c. Add to pill fluid to be pumped to cover the entire weak section of the wellbore before pulling out of the hole to mitigate whole fluid losses while running casing (especially for deepwater drilling).
  - d. Add to pill fluid to be pumped ahead of a cement spacer fluid to cover the entire weak wellbore to prevent induced fluid losses while cementing (especially for deepwater drilling).

## **2. BaraShield-663 LCM Pretreatment Pill Volume and Concentration**

For preventing induced fractures, the volume and concentration of BaraShield-663 is preferably defined by using the SEM.

### **STRESS-SHIELD Engineering Method to Prevent Induced Mud Losses:**

Typically, for preventing induced mud losses into a weak formation, the concentration of BaraShield-663 LCM is around 20 ppb in continuous drilling fluid for drilling hard or stiff formations. A typical example can be drilling through a depleted formation in North Dakota or Canada. When the formation is young or less compacted, it may be soft and less stiff. Preventing induced mud losses into such formations may call for BaraShield-663 LCM at a concentration of around 50 ppb. A typical example is drilling a weak formation in deepwater Gulf of Mexico. In order to keep the particulates at a relatively low concentration for offshore deepwater applications, BaraShield-664 LCM particulates, which are capable of sealing wider fractures, are recommended instead of BaraShield-663 LCM.

For preventing fluid losses to induced fractures, the treating concentration of BaraShield-663 LCM may be uniquely defined by the SEM to reconcile rock mechanical properties with the required spurt loss control of the sealing performance. **Contact Global Technical Advisors for support on this calculation and application.**

The inputs needed for using the “STRESS-SHIELD Engineering Method” include:

- Target Wellbore Strength (Pressure) Improvement

- Young’s Modulus
- Poisson’s ratio
- Hole diameter

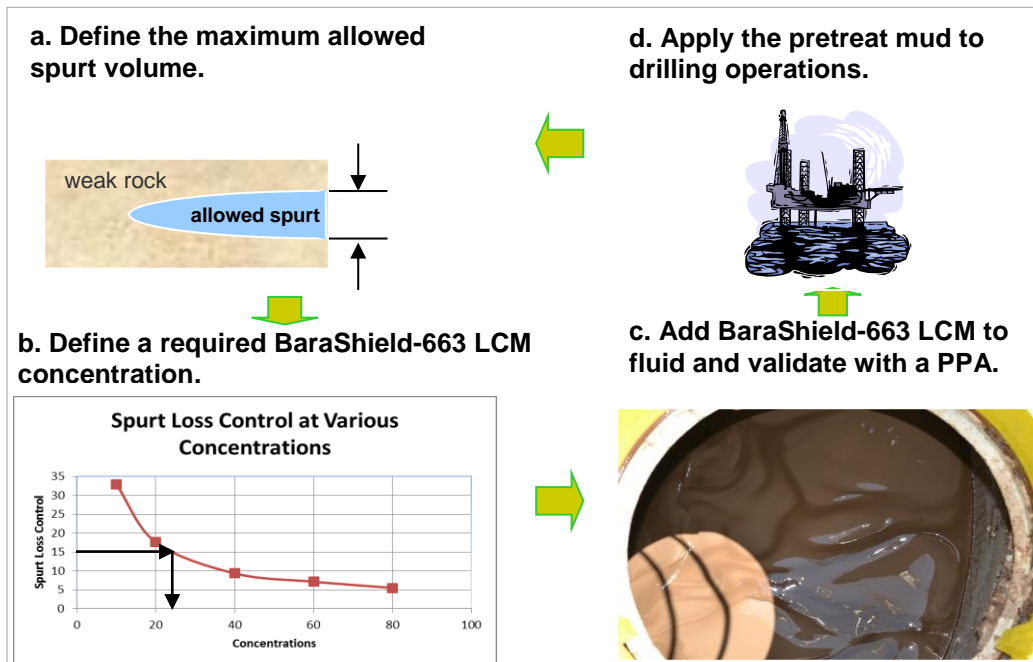
When the rock properties of Young’s Modulus and Poisson’s ratio for a well are not available, SEM allows a “bigger-hammer” approach such that these parameters can be conservatively estimated with experience in the area to generate a conservative or higher concentration of BaraShield-663 LCM.

“STRESS-SHIELD Engineering Method” typically includes the following steps:

- Define the maximum allowed spurt loss volume using the “Engineering Method” calculations.
- Define a preliminary minimum concentration of BaraShield-663 LCM to control the mud spurt loss at a value less than the maximum allowed spurt loss volume defined by the SEM calculations.
- Add the defined concentration of BaraShield-663 LCM in the fluid to be treated (drilling fluid, spacer, cement, etc.). The sealing performance of the BaraShield-663 LCM fluid can be checked by testing the fluid against an appropriately sized slotted disk and PPA.
- Apply the BaraShield-663 LCM fluid to the drilling operation.

\*Note: It is recommended to perform a PPA test on a 500 micron or narrower slot to evaluate the sealing performance of BaraShield-663 LCM.

The following is a summarized example of the “STRESS-SHIELD Engineering Method” process.



While drilling, an API 40 mesh, or coarser, screen is required to retain the majority portion of the BaraShield-663 LCM particulates in the active fluid system and remove the larger drilled cuttings during circulation. As with any drilling fluid with LCM in background, it is recommended to also run sweeps of BaraShield-663 LCM for every stand drilled, compensating for those LCM ground down during circulation. Optionally, shale shakers can be by-passed to retain the BaraShield-663 LCM particulates.

**Volumes for the “STRESS-SHIELD Engineering Method”:**

- For drilling, it is recommended to treat the total active fluid system with BaraShield-663 LCM.
- For loss prevention while running casing or cementing, sufficient volume to cover the entire open hole, or as a minimum, a specific weak zone is recommended.

***Contact Global Technical Advisors for support on this calculation and application of “STRESS-SHIELD Engineering Method”.***

**Empirical Method for Stabilizing a Wellbore/ Preventing Seepage Mud Losses:**

For pretreatment applications, BaraShield-663 LCM must be applied to the entire volume of the active circulating fluid system. The concentration can be 10 ppb or higher for general drilling operations through unstable formations. If fractures may exist, the concentration may need to be around 20~40 ppb. An API 40 mesh screen (or coarser) is required to retain the majority portion of the BaraShield-663 LCM particulates in the active fluid system, while removing the larger drilled cuttings during circulation. It is normally not necessary to by-pass shale shakers while drilling the interval since the sealing can be well maintained even when some of the coarse particulates are removed. If an interval is not too long (such as a few hundred feet), it may be possible to safely by-pass shale shakers while drilling the interval. This is particularly true when drilling with OBM/SBM drilling fluid or drilling non-reactive formations. Proper solids control equipment may have to be used in order to prevent any buildup of excess solids in the system. After drilling through the potential loss formations, the shale shakers can be brought back in line.

In order to maintain the effective concentration during drilling, it is recommended that sweep pills containing a higher concentration of BaraShield-663 be pumped at a normal pump rate for drilling after each stand drilled. A general rule of thumb is to cover a minimum of 200 ft of open hole. A customary volume of such pills is 40-80 bbls at a concentration of approximately 40 ppb or higher.

**3. BaraShield-663 LCM General Mixing Procedure**

- Using proper personal protective equipment (PPE), add BaraShield-663 LCM to the designated fluid into the mixing tank via the hopper; turn on all agitators.
- Add BaraShield-663 LCM through the hopper at a rate to distribute it throughout the entire treating volume.



#### **4. Limitations for BaraShield-663 LCM**

BaraShield-663 LCM is designed to seal fractures or pores up to approximately 500 microns. It may not be appropriate for sealing larger flow paths such as a vug or a leaky fault.