



# STOPPIT<sup>®</sup> LCM Standard Field Application Procedure

**Prepared for:** All Customers

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## 1. Overview

STOPPIT® lost circulation material (LCM) is a particulate-based, “Engineered, Composite Solution” that is designed to mitigate partial to severe drilling fluid loss rates (> 50 barrels per hour; > 8 cubic meters per hour). The composition of STOPPIT LCM is optimized to comprise specific materials with precise sizes at a unique engineered concentration. This saves the operator from incurring more non-productive time while mixing the individual components of the blend. The multi-modal composition is designed to provide superior sealing performance in loss zones with fractures varying between 200 and 2500 microns, or greater. In addition to its logistic and technological advantages, STOPPIT LCM provides our customers with a solution that has exact QA/QC specs while remaining cost competitive with products currently on the market that have little or no quality control.

The large PSD material is designed to be used in pill treatments, and should not be used as background LCM. It can be applied conventionally as a product in a pill formulated in water, synthetic oil, or the drilling fluid (WBM, SBM and OBM). Since there are no reactive components, the STOPPIT material can be kept mixed ahead to be applied immediately upon losing circulation.

Spotting a STOPPIT LCM pill helps save rig time and operational costs since it requires no trips out of the hole, no special pumping or mixing equipment and no specialized spacers. It can be applied via sweep, hesitation squeeze, or pump-spot-soak operations. The preferred application technique is a hesitation squeeze in a water base pill.

When a lost circulation treatment does not stop the fluid loss, consideration should be given to the following:

- Was the lost circulation pill placed in the proper location?
- Did the pill have sufficient volume/concentration of material?
- Were the type and sizes of particulate material appropriate for the scenario?

When drilling in lost circulation prone areas, it is recommended to run a treating sub in the drillstring. This equipment can be opened/closed multiple times and allows the pumping of large lost circulation material without plugging bit nozzles or small clearances in the BHA. However, 80 lb/bbl pills of STOPPIT LCM have been successfully pumped through bit nozzles as small as 11/32” and an MWD tool that was equipped with a 1.92” I.D. positive pulser.

## 2. Mixing Table

- The following Mixing Table provides approximate amounts of Water and Barite for preparing weighted STOPPIT LCM. The SG used for STOPPIT LCM is 1.50. For critical weights, use DFG™ software for additional verification.

<b>Weight SG (ppg)</b>	<b>Water bbl (m<sup>3</sup>)</b>	<b>BARAZAN ppb (Kg/m<sup>3</sup>)</b>	<b>BAROID ppb (Kg/m<sup>3</sup>)</b>	<b>STOPPIT LCM ppb (Kg/m<sup>3</sup>)</b>
9.0 (1.08)	0.845 (0.134)	1.0 (2.86)	1 (4)	80 (229)
9.5 (1.14)	0.826 (0.131)	1.0 (2.86)	29 (82)	80 (229)
10 (1.2)	0.808 (0.128)	1.0 (2.86)	56 (161)	80 (229)
10.5 (1.26)	0.789 (0.125)	1.0 (2.86)	84 (239)	80 (229)
11.0 (1.32)	0.771 (0.123)	1.0 (2.86)	111 (318)	80 (229)
11.5 (1.38)	0.752 (0.12)	1.0 (2.86)	139 (397)	80 (229)
12.0 (1.44)	0.734 (0.117)	1.0 (2.86)	166 (475)	80 (229)
12.5 (1.5)	0.731 (0.116)	0.8 (2.3)	198 (566)	70 (200)
13.0 (1.56)	0.713 (0.113)	0.8 (2.3)	226 (645)	70 (200)
13.5 (1.62)	0.694 (0.11)	0.8 (2.3)	253 (724)	70 (200)
14.0 (1.68)	0.676 (0.107)	0.8 (2.3)	281 (802)	70 (200)
14.5 (1.74)	0.657 (0.104)	0.8 (2.3)	308 (881)	70 (200)
15.0 (1.8)	0.638 (0.102)	0.8 (2.3)	336 (959)	70 (200)
15.5 (1.86)	0.636 (0.101)	0.7 (2.0)	368 (1050)	60 (171)
16.0 (1.92)	0.618 (0.098)	0.7 (2.0)	395 (1129)	60 (171)
16.5 (1.98)	0.599 (0.095)	0.7 (2.0)	423 (1208)	60 (171)
17.0 (2.04)	0.597 (0.095)	0.6 (1.7)	455 (1299)	50 (143)
17.5 (2.1)	0.578 (0.092)	0.6 (1.7)	482 (1377)	50 (143)
18.0 (2.16)	0.559 (0.089)	0.6 (1.7)	510 (1456)	50 (143)

- **STOPPIT LCM is an “Engineered, Composite Solution” (one sack). It should be used on its own and is NOT recommended to be Supplemented with Conventional LCMs like BARACARB®, WALL-NUT® or BAROFIBRE®. Preferred Supplemental materials are DIAMOND SEAL® LCM, and BAROLIFT® LCM or BaraLock®-666.M and/or BaraLock-666.C LCM.**
- In case of most severe lost circulation scenarios, 3.5 ppb of DIAMOND SEAL® LCM and 1 ppb of NaCl may be added to the above formulations. Note that upon the addition of DIAMOND SEAL LCM and NaCl, there could be an increase of approximately 1 bbl compared to a 50 bbl planned volume. Again, use DFG software for estimating accurate amounts.
- If DIAMOND SEAL LCM swelling polymer is added to the LCM pill, it should be added last, immediately prior to pumping the pill. If DIAMOND SEAL LCM is used (recommended @ 3.5 ppb), then 1 ppb NaCl should be added as a retarder prior to adding the DIAMOND SEAL LCM. If the pill becomes too viscous prior to adding the suggested amount of DIAMOND SEAL LCM – pump immediately. Normally, the DIAMOND SEAL LCM is only used when treating carbonates with large open fractures, but can be used in any extreme loss situation. DIAMOND SEAL LCM will inhibit the high-fluid-loss character of the pill, but these pills are still advised to be used via hesitation squeeze to deliver the solid material into the fractured loss zone. The loading of DIAMOND SEAL LCM could be varied/increased and fibers could be added depending on the loss severity. However, the formulation would then need to be tested in lab.

- At high temperature applications (>250 F), STOPPIT LCM is susceptible to settling and hence it is recommended to prepare the pill in fresh water with 0.5 – 0.75 ppb BARAZAN® D PLUS and 5-10 ppb AQUAGEL® for better suspension (barite may be added for weighting the pill).

### 3. Pumping Procedure

STOPPIT LCM can be applied using sweep, hesitation squeeze, or pump-spot-soak operations. The detailed procedure given is for a hesitation squeeze treatment with a STOPPIT LCM pill.

A hesitation squeeze procedure differs from many loss circulation remedies. When squeezing into a loss zone, the liquid phase (usually water) is filtered out of the slurry. A firm, dense plug remains within the fracture or permeable zone rather than at or near the face of the wellbore. This promotes “fracture-tip screen-out” and prevents the propagation of the fracture. It also minimizes the possibility of the seal being removed during drilling operations and/or repeated remedial loss treatments. Water-based, high-filtrate pills are recommended for wellbores with either water or oil/synthetic based fluids.

The volume of pill mixed and pumped is many times controlled by factors other than the estimated need of what is required. It is safe to say that the initial application should be as large a volume with as high a concentration of material that is practical to mix and place on the specific drilling rig. The greatest unknown in many cases is the actual location of the loss zone. Larger volume pills have a higher probability of success when this is the case.

1. The lost circulation material pill should cover the entire potential lost circulation zone, if at all practical. To insure this is done, mix twice the open hole volume or, if that is not possible, mix twice the volume of the interval to be treated. Ideally, enough slurry should be available to cover all potential loss zones, as well as enough excess volume available for squeezing operations.
2. Begin with approximately 80% of the prescribed volume of water (see Mixing Table). To the water, add BARAZAN, or an equivalent viscosifier; add the STOPPIT LCM ; if mixing a weighted pill, add BAROID® [or, preferably, SWEEP-WATE®, due to its superior particle size distribution (PSD) for lost circulation applications]; and then the remainder of the water.
  - a. If DIAMOND SEAL LCM swelling polymer is to be used as a supplement to the STOPPIT LCM pill, add the calculated amount of NaCl to the pill before you add BAROID [or SWEEP-WATE] weighting material. Then continue to follow the above mixing order and add the suggested amount of DIAMOND SEAL LCM last, prior to pumping (per the notes section that accompanies the previous mixing table). Allow adequate mixing time for dispersion of the DIAMOND SEAL LCM through the entire pill volume.

3. When space and equipment allows, a contingency pill should be mixed and maintained ahead of time to be pumped at the first sign of lost circulation. STOPPIT® LCM is specifically recommended for this application. When mixing a pill ahead of time, it is preferable to mix it unweighted, then add any required weighting material prior to pumping along with the NaCl and DIAMOND SEAL LCM if used as a supplement.
4. If spotting a weighted slurry, it should have a density near the drilling fluid in use, but does not have to be exact (+/- 0.50 ppg).
5. Placement of the bit at the proper depth is critical, but many times must be done without precise knowledge of the loss zone location. Preferably, the bit will be located inside casing above the loss zone. For a long open hole interval, this may not be practical. For these cases, run the bottom of the drill pipe or bit to +/-100 ft above the loss zone and that will allow 75% of the total pill volume to be displaced into the open hole while retaining 25% of the pill volume in the drill pipe with which to squeeze. A volume of 10-20 bbls is considered a minimum squeeze volume to remain inside the drill pipe or casing above the casing shoe. To lower the probability of stuck pipe, you do not normally run the pipe into or below the loss zone.
6. While the pill is inside pipe, the pump pressure is not exerted on the formation, so high flow rates can be used to pump the LCM pill until it reaches the end of the pipe, bit or PBL sub. This can be on the order of 5 bpm (600 lpm). Before beginning the hesitation squeeze, check the annulus. If no fluid can be seen, use the fill-up line and fill the hole.
7. Once the LCM pill is located at the bit, open-ended pipe, or the PBL sub, close the annular BOP, and pump the slurry at 1.0-1.5 bpm (120 – 180 lpm). This will direct the slurry downhole to the point of loss. If pumping pressure allows, pump 75% of the total LCM pill volume; leaving 25% of the total pill treatment volume in the casing or above the treatment interval. Preferably, this is a minimum of 10-20 bbl (2 – 3 m<sup>3</sup>). NOTE: If DIAMOND SEAL LCM is added as a supplement, displace the entire pill from the drill pipe into the open hole prior to squeezing.
8. Begin the hesitation squeeze by pumping at 0.25 – 0.50 bpm (40 – 80 lpm). When a pressure of 50 psi (3 bar) is obtained, discontinue pumping for 10 – 15 minutes. Repeat this procedure until 50 psi (3 bar) can be maintained, then attempt progressively higher pressures in 40 – 50 psi (2 – 3 bar) increments. With this hesitation squeeze method, there will be a pressure bleed off each time the pump is stopped. However, with each successive squeeze, the pressure should stabilize at a progressively higher level.
9. If no pressure builds, then wait two hours – particularly if swelling polymer is a part of the treatment and repeat step #8 (above). If no pressure is seen, the treatment has not been successful and must be repeated with the same pill or a modified treatment selection. Experience in an area will generally dictate the exact path to follow, but this should be decided during the well planning stage.



10. A 200 – 600 psi (15 – 40 bar) squeeze is generally considered to be very good but, if possible, you want to squeeze to the equivalent mud weight (ECD) required to drill ahead in this interval or run casing and cement. When maximum holding pressure is obtained, **shut down for 4 hours**.
11. Bleed the pressure from the annulus slowly, and then recirculate the remaining LCM pill out of the hole.
12. Run the drill pipe back into the hole slowly, monitoring the weight indicator and checking for bridges. Wash to bottom, drilling any LCM plug – if encountered. Any remaining LCM may be retained in the drilling fluid and removed at the shakers.

#### 4. Additional Notes

- There are 2 key factors to obtaining a best possible chance for a successful LCM squeeze:
  1. a slurry with a high solids content and high fluid loss should be prepared
  2. the placement of the slurry at the proper location in the wellbore so that it can seal the loss zone
- Do not hurry to build squeeze pressure; patience and time are necessary to obtain a successful squeeze
- Do not mix a weighted slurry too far in advance of using it; all weighted fluids are subject to barite settling over time.
- Use a low pressure gauge to accurately measure squeeze pressure; if possible, rig-up equipment so that drill pipe and casing pressures can be monitored easily and precisely.
- If the slurry is to be placed through the bit or BHA, install a PBL sub (preferred), drill pipe screen or choke nipple. The choke nipple should be smaller than the bit nozzle size. This will prevent plugging of the bit, and foreign objects can be easily removed at surface to avoid disrupting operations.
- No special equipment is needed to pump low weight slurries (<12 ppg or <1.44 S.G.). The slurry can be mixed in a clean, uncontaminated mud pit and pumped with rig pumps. The operators may consider using a cement company blender and pump unit to place weighted slurries of over 12 ppg (>1.44 S.G.). This gives better control of squeeze pressure and avoids contamination.
- Attempt to accurately determine the location of the loss zone, to increase the chances for obtaining a successful squeeze (temperature log and/or MWD).
- Always have a sufficient quantity of material on location for additional squeeze procedures.
- If supplementing the LCM pill with synthetic fibers larger than 3mm in length place the slurry open-ended or through the PBL sub. If you are unsure, consult the appropriate lost circulation subject matter expert.