# Request for Proposal

**Topic:** Study of The Impact of Macro-Scale Fractures on Seal Integrity

**Background:** Modern 50 and 120 psi seals are designed to function as passive shear-resistant plugs or have sufficient tensile strength to prevent flexural failure. Many of these modern seals are constructed from pumpable materials with strength properties that require seal thicknesses of 10-20 ft to meet the MSHA strength requirements. The fundamental premise in these designs, constructions and approvals is that the seal material is homogenous throughout the body of the seal. MSHA seal inspections currently require penetrometer testing of the seal skin to measure/confirm seal material (compressive strength) as a surrogate for assessing seal strength, but this skin test does not truly assess the material integrity or strength conditions of the body of seal.

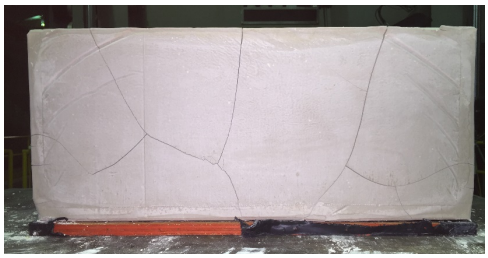

*Figure 1. 28 in by 12 in block of seal material showing macro-scale fractures.*

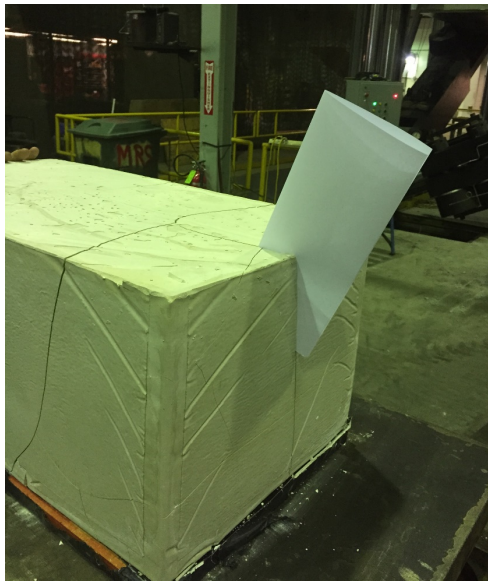

*Figure 2. Sheet of paper place in macro fracture of seal material.*

The material properties (shear, compressive strength, tensile strength, and shrinkage) are all based on laboratory "core-sized" specimen testing. While there are normally physical scaling effects associated with structural material assessment, seal materials may, and have been known to, be damaged by high levels of heat generation during curing of these thick seals that is not evident in laboratory (core-sized) testing. The heat of hydration during curing can cause macro-scale fractures to occur in seal structures. Figures 1 and 2 illustrate macro-scale fractures in one type of pumpable seal material being considered for seal construction. The impact of these fracture and macro-scale effects are unknown and need to be investigated and understood to ensure seal integrity is meeting the design requirements and approval performance expectations.

**Project Goals:** Determine the impact to seal integrity and strength of macro-scale fractures and/or other material damage or degradation resulting from full-scale seal construction.

**Scope or Work:** The submitter has flexibility to tailor the proposed scope of work to meet the project goals, but the following requirements must be met.

<u>Phase 1 – Material Assessment</u>

- Review seal approvals and classify which designs are approved based on flexural strength and which are based on shear strength (i.e. plug designs).
- Estimate the number/percentage of each design in use in the industry

- Identify the existing seal materials used for seal construction and their material chemistry properties. Categorize materials based on material constituents and chemical reactions for curing.
- Inquire from MHSA the results of the heat generation test samples for approved seal products.
- Prepare test samples for each material category of sufficient size to examine heating effects (noting the 4 x 4 x 2 ft size required for MSHA seal approval heating tests).
- Identify any macro fractures from the tests, their scale, intensity and other pertinent properties.
- Prepare report of findings assessing macro-scale material damage for seal materials, especially brittle pumpable materials.

Phase 2 – Macro Scale Fracture Impact Assessment on Seal Performance

- If the findings of Phase 1 indicate that macro fractures exist in large-scale seal material samples, then work to determine their impact on the seal performance capabilities.
- Since large-scale seal testing is mostly unattainable, the expectation for this assessment is through numerical modeling.
- Develop the appropriate modeling approach and conduct a parametric study to evaluate what size and density of macro scale fractures would reduce seal capacity and to what degree.

Phase 3 – Alternative Material Opportunities

- If macro fractures are found to exist and if they are shown to significantly degrade seal integrity and/or strength, then alternative materials can be suggested for evaluation.
- Since seal approval generally takes years to achieve, the end goal here is to prepare a proposal for evaluation of alternative seal materials or material additives that might provide superior seal construction.

**Funding Plan:** The project will be funding in phases according to the Scope of Work with funding for subsequent phase dependent on a successful outcome in the previous phase.

**Submission Requirements:** The submitter is required to submit a proposal not to exceed 20 pages in length to provide documentation of how the scope will be accomplished, the project team and its experiences, a detailed budget to support the project costs and a project timeline. Proposals with advanced planning or more detail with how the scope of work will be accomplished will be rated higher than those lacking detail.

**Evaluation Criteria:**

- (35%) Knowledge of seal design practices including material chemistries and physical properties
- (25%) Experience in numerical modeling relative to this project effort
- (20%) Knowledge of MHSA seal approval specifications
- (20%) Cost and timeline validation