MEMO

TO: Davitt McAteer
FROM: Monte Hieb
DATE: July 11, 2006
SUBJECT: Response to questions from email dated July 3, 2006

Questions that you recently posed in your email dated July 3, 2006 are addressed individually below. Your questions (indicated in **bold** letter style) are followed by my brief response (indicated with“R_ ”).

**Monty;** If possible could you set out information concerning the four topics which I have listed below:

Q1.) The use of Mitchell Barrett Seals as an alternative to Omega or other seals to provide protection against lighting strikes in sealed areas.

R1. Mitchell-Barrett Seals are built of a crossed-linked double-row of solid blocks that are hitched into the mine opening perimeter, and typically incorporate a center pilaster.

This type of seal has withstand static pressures of 95 psi in tests conducted at the NIOSH Lake Lynn Experimental Mine, and is a standard seal design against which seals of other materials and design types are frequently compared. Seals of other types are referred to as "alternative seals."

![Figure 1](image.png)  

**Figure 1.** Typical Mitchell-Barrett type seal construction

In the aftermath of the explosions at Sago and Darby No. 1, MSHA Tech Support personnel indicated that new seal construction would be required to be of the Mitchell-Barrett design, until further notice. On June 21, 2006 MSHA issued Program Information Bulletin No. P06-14 which specified new "alternative seals" that were to be built would have to be submitted to MSHA for review. A copy of this is attached as file: MSHA-pib06-14.pdf. Part of the procedure for requesting review and approval of alternative seal designs includes:
"...listing of methods and materials must be approved under the applicable NIOSH protocols in effect at the time of revision."

At the present time no one I have spoken to knows what this is specifically referring to, especially with regard to "materials." Further, the June 21, 2006 memorandum adheres to the old legal standard of 20 psi static pressure as the criteria for withstanding an explosion, which I think will prove to be inadequate.

Last week I spoke with a representative of Minova who indicated they had just met with MSHA and their pumpable seal called "Tekseal" has been approved as an alternative seal. At this writing, I have not confirmed this with MSHA. This seal does not require hitching.

**Q2.) How we could address the question of bottom mining or the change in the cross sectional area mined and the impact on the velocity of an explosion. Particularly how such change might increase the velocity of an explosion.**

R2. Bottom-mining has the potential to increase the force of a propagating blast wave two ways:

a) When bottom-mining is selective (i.e. floor ramps and drop-off's are created) the resulting features can create turbulence and enhance gas mixing, which increases the combustion efficiency and speed of the blast wave

b) Where a propagating wave passes through a restriction in cross-sectional area the velocity pressure is increased. Since, static pressure + velocity pressure = total pressure, reducing the cross-sectional area in the direction of blast propagation increases the resultant pressure. For example, a reduction of the cross-sectional area of the downstream end of a blast chamber by 1/2 increases the velocity pressure, theoretically, by a factor of 4.

I don't recommend that we eliminate bottom-mining as a solution to this phenomenon, as this would unduly prevent recovery of coal reserves when other remedies are available. I would propose, instead, that reinforcement of the seal itself is the most practical approach. For instance, the pumpable seal or a Mitchell-Barrett seal may be able to withstand these forces. If a pumpable seal is in need of additional anchorage (since it is not a hitched seal) this can be accomplished by simply adding an integrated rebar cage anchored around its perimeter.

The "venturi effects" that are the basis for this pressure increase during an explosion need to be better-understood in order to realistically develop a design criteria. We should
conduct rigorous testing and computer modeling to acquire the needed data to establish what this design criteria should be.

Q3.) Methods to retrofit the currently existing Omega style seals to ensure that explosive forces will not destroy seals and enter the working section of the mine.

R3. Existing Omega Seals can be reinforced in a number of ways. Perhaps one of the most efficient and effective alternatives in my opinion is to install a “Tekseal” or equivalent seal just outby and adjacent to the existing Omega Seal. Such seals typically involve erecting two wood frame forms lined with a brattice cloth which is then pumped full with a special cementaceous grout under pressure. In this case, the existing Omega Seal could serve as the inby form, so only one form is needed outby. Such pumpable seals have been around for years and their practicality well-demonstrated. They are not usually hitched, because the grout under pressure effectively fills cracks and voids as the seal is brought up. However, in the event better anchorage is required to resist violent explosion forces, this could be accomplished by adding in internal rebar cage as is shown below. The rebar are a lattice of vertical and horizontal members inserted into holes drilled into the roof, ribs, and floor before outer form construction—all members are tied one to another with simple wire twist ties.

Figure 2. One method to retrofit and buttress existing Omega Seals with anchored rebar reinforcements inside a cementaceous “pumpable” seal, where very large resistance to explosion forces is desired.
The necessity to supplement sliding resistance in this way has yet to be determined. A reinforcement scheme using the rebar cage concept could also be accomplished with “shotcrete” or “gunite” construction materials, although installation efficiency and effectiveness would be different.

Q4.) What experts or expertise is needed to go forward in the investigation of lighting or other matters in the Sago investigation?

R4. We require experts and expertise to assist us in the following areas at this time. We have experts already in mind. We require at this time the ability to contract and pay for these services.

1) Lightning Experts

   a) Review the data from the various lightning detection networks in order to independently determine if there are any other lightning strikes which may have occurred around the time of the explosion, but were intentionally or inadvertently overlooked. For example, we know that cloud-to-cloud strikes and strikes registering less than 3-5 kA are routinely filtered from the data before it is published.

   b) Perform the necessary calculations and evaluations of our data to determine if the numbers support or refute the probability that lightning or electromagnetic energy having entered the mine via a particular route. We have several possible routes at this time, but no direct, continuous electrical connector.

   c) It is necessary to determine what role the wire roof mesh and abandoned pump cable might have played in the explosion in order to modify operational practices, if necessary, to avert further recurrences.

2) Combustion and blast wave propagation Experts

   a) From the forensic data we have relating to explosive gas mixtures, mine geometry, plate bending, etc. at Sago Mine, we are in need of the right expert(s) to assist us in determining what magnitude of blast forces were likely generated from the explosion and what role effect bottom-mining may have played increasing those forces.

   b) The results from the Omega Seal Explosion Tests being conducted at the NIOSH Lake Lynn Experimental Mine can be used to calibrate and validate existing computer models, which can then be used to do computer simulations to evaluate the effects of bottom-mining. NIOSH has advised us that the assessment of bottom-mining effects cannot be performed through direct experimental methods at their testing facility, so if this important aspect is to be understood it appears that our
best and perhaps only option is through computer modeling. Therefore, it is essential that the models be properly refined and validated initially. NIOSH has expressed interest in participating with our agency and our selected experts in this effort. MSHA has reportedly selected the Army Corp of Engineers as their experts in this regards.

3) Electromagnetic conductivity/resistivity Experts

    a) At the suggestion of WVMHS&T a consulting firm with capabilities of studying inherent ground conductivity anomalies has been retained to assess the conditions between the surface and the mine void in the area behind the seals at Sago. This work is being funded by ICG. Consequently, the direction this work is going is also being directed by ICG.
    
    b) Depending how this work progresses, financial participation or perhaps an additional expert working at the direction of WVMHS&T may be required.


    a) We will need to contract with one or more vendors to perform engineering tests on various mine materials including roof plates/panes, Omega Blocks, roof rock samples, water samples, etc.
    
    b) As testing and analysis progresses, the need for additional expertise and tests other than those specifically mentioned above may be needed.