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Pennsylvania Technical Advisory Committee Diesel Powered Equipment

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By: Ada 7-20-04

July 12, 2004

Joseph Scaffoni, Director
Bureau of Deep Mine Safety
Fayette County Health Center
100 New Salem Road, Room 167
Uniontown, Pa 15402

Re: TAC Audit-Review

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Dear Mr. Scaffoni:

Article II-A of the Pennsylvania Bituminous Coal Mine Act of 1961 provides for the use of diesel-powered equipment in underground bituminous coal mines. Section 224-A created a Technical Advisory Committee for the purpose of advising the Secretary regarding implementation of Article II A.

On January 29, 2004, the Technical Advisory Committee (TAC) met with Joseph Scaffoni, Director of the Bureau of Deep Mine Safety, to discuss the need for a review of Pennsylvania's underground diesel law. The TAC stated that although the diesel rule was in effect since 1997, there has never been a review of this rule. It was decided the TAC would initiate a diesel Audit-Review. At that time, the Director asked the TAC to set an agenda for the Audit-Review and to meet again with the Director and Mine Inspectors when the agenda was finalized.

On January 31, 2004, the TAC submitted to the Director an agenda for the diesel Audit-Review. The TAC met with the Director and Mine Inspectors on February 20, 2004, to review the agenda and, after a few minor changes, the agenda was accepted and the TAC was given permission to begin the Audit-Review.

The following is the agenda the TAC used for the Audit-Review:

- Inspection and examination of all required record keeping books.

- The visual examination and evaluation of the existing underground diesel fleet as well as observation of mine personnel while performing required maintenance and testing
- Communication with all salaried and hourly employees whose regular duties are involved in the operation of the diesel fleet in order to gain understanding of what areas of the law are working, as intended, and what areas may need to be addressed in the future. This will also serve as a platform to exchange knowledge between these parties.
- Emissions testing of each type of engine and after-treatment system being used in Pennsylvania.
- Collection and evaluation of all information gathered which will be used to issue a report outlining what areas, if any, need addressed in the way of future training, amendments to the law, or TAC investigations for alternate methods of meeting the law. The report should also create any training material that is deemed necessary by this review for use in future training presentations.

At this time, Pennsylvania has two underground mines, RAG Cumberland and RAG Emerald, which have active diesel fleets. The remainder of this document will elaborate upon the status of the diesel fleet at each of these mines as well as our recommendations for improving the operating performance of the diesel fleet.

Audit-Review RAG Emerald Mine

2-24-04 The TAC explained the Audit-Review agenda to a representative of the Mine Health and Safety Committee and together, we conducted an audit of all applicable record books at the Emerald Mine. The results of this audit are as follows:

- The required 100 hr. emissions tests are being completed in accordance with the requirements of Section 218-A. At each 100- hour test, the heat exchanger is being cleaned and all filters are being changed. In the few instances where the 100 hour test was performed several hours late, it was well documented in the record book, promptly followed up by mine management and was handled in a manner that presented no detriment to the safety or health of the workers.
- The CO numbers recorded as part of the required emissions testing are representative of the performance expected for each listed diesel engine.
- The required maintenance books have all required information listed. The maintenance records books are very good and well documented.
- Overall observation is that all records are being maintained as required by law and the overall maintenance program of the operation is excellent.

Recommendations:

- The TAC recommends that all maintenance books have the original baseline emissions numbers and date of the original baseline together with machine serial number prominently displayed on the front cover of each record book.
- When a machine is transferred from one mine to another, the maintenance books must go with the machine.
- There is no need to check items such as speed, torque, etc more than once during each 100 hour test.
- Emissions testing should be performed in high gear rather than 2nd gear.
- The record books exhibited a desire by union and management to do a professional job and they should be commended on the same.

3-4-04

The TAC met with representatives of the Emerald Mine Safety Committee and mine management to discuss the purpose of the review and to ask if there were any specific issues that needed addressed while the review was taking place. The following are some of the issues that were brought to our attention at this time. In order to simply this report our answer is stated at this time:

- (1) Blue smoke emitting from the 20 ton motors under heavy lug conditions- This is probably due to unspent fuel accumulating on the oxidation catalyst during light duty cycle applications. When the engine is sufficiently heated, it will burn off as white smoke for a brief period of time.
- (2) Why does a "blue haze" appear sometimes when pulling under heavy load?-This is probably due to oil bypassing the cylinders under heavy load, accumulating on the oxidation catalyst, and burning off under heavy load.
- (3) If backpressure climbs into excessive range, what should the operator I do?-You can continue to operate the machine but need to have it checked at the end of the shift before using again.
- (4) What is unnecessary idling?-Since diesel equipment emits the highest CO emissions at idle condition, unnecessary idle should be avoided. Common sense needs used here and each operator should be able to determine when the machine should be shut off or if the idling is a part of the normal work or maintenance cycle.
- (5) Status of the use of water injectors- Use these when you are under load such as going up a hill or induce a load by performing a mini stall test. Make sure the water temperature is at least 160 degrees and preferably 170-180 degrees before using the injector. Pete Keating has stated that the water injectors on the jeeps are not to be used.
- (6) Can a trained diesel operator change a diesel particulate filter?-We believe a trained diesel operator can be allowed to change the filter if he reports the same to a person designated by the operator and insures the filter is properly disposed of.

- (7) Can a non-qualified operator be trained to move diesel equipment?-NO but he can be trained to move the equipment in the event of an emergency.
- (8) Is it necessary to change an intake air filter during each 100-maintenance interval?-NO. It must only be changed when it no longer functions as intended.
- (9) Proper disposal of all used filters- Put in its original container or plastic bag and deposit in the garbage car..
- (10) Is it proper, under the law, for a trained diesel operator to cap off all needed fluids during the pre-opt inspection- Yes as long as it is recorded in the Pre-Opt book or called out as directed by the operator.
- (11) How many fuel storage facilities can be located in a mine?-As many as are required by the operator as long as they are in compliance with the Act.
- (12) Should the treated and untreated ports, located in the operator's compartment, have secondary ports installed closer to the diesel engine, to be used in the event of questionable CO numbers being taken at the ports located in the operator's compartment?- We believe this should be encouraged under "best practices" and is invaluable in dealing with questionable emission readings.
- (13) What is the effect of the smell of the diesel?-You can not equate smell to a problem with emissions or a health issue. There is a health issue if your eyes or throat are burning and smoke is present. The smell is probably caused by the oxidation catalyst.
- (14) Can you fuel with cans?-Only in an "emergency situation". It is not an emergency if you run out of fuel because you did not perform a proper pre-opt.

With the above listed concerns in mind, the TAC began its Audit Review at the Emerald Mine.

3-12-04

The TAC observed an Emerald Mine diesel mechanic as he performed the required 100 hr. maintenance test on ERO 5028 which is a Brookville 20 ton locomotive powered by a Caterpillar 3306 engine, 150 hp diesel engine. The mechanic verbally walked through his regular 100 hr. maintenance routine.

Following are other observations noted at this time:

- We found the maintenance procedure to be adequate and to comply with the requirements of Section 216-A of the law.
- The TAC also performed emissions test of this piece of equipment and found the emissions, both treated and untreated, to be representative of this engine model.
- Note: The inside of the filter canister was wet with either oil residue or unspent fuel.

3-26-04

The management of Emerald Mine had previously noticed unspent fuel captured in a particulate filter, during normal filter change, on the ERO 5136 personal carrier. They suggested the TAC investigate this condition. Following are our observations of this investigation:

- The TAC continuously recorded emissions on this engine while traveling throughout the mine. The Cummins 3.3b engine failed to achieve proper operating temperature under normal operating conditions. The water temperature reached a maximum temperature of 130⁰F during our travels which is well below normal operating temperature for this engine.
- After noticing this condition, the TAC performed a torque stall test, which caused the engine to achieve proper operating temperature, and the unspent fuel burned off as a cloud of white smoke. Prior to the engine achieving the proper operating temperature, the treated CO emissions were greater than 100 ppm although, after the engine had achieved proper operating temperature, the CO emissions were well within the requirements of the law. The TAC believes the personal carrier in question does meet the requirements of Section 203-A(b)(2) of the diesel law in that at normal operating temperatures (170-180 degrees Fahrenheit) CO emissions are under 100 ppm; however, we also believe the failure of this piece of equipment to reach normal operating temperature is a potential problem due to the accumulation of unspent fuel in the after-treatment system and the fact that CO emissions can be significantly reduced if the engine is modified to achieve an operating temperature of 170-180 degrees Fahrenheit during its normal light duty cycle.
- The management of Emerald Mine in an attempt to solve this problem set up a conference call on 3-31-04 with representatives from the following entities: Brookville Mining Equipment, Cummins Bridgeway, TAC and Dry Systems Technologies. The purpose of the conference call was to discuss the inability of the Cummins B3.3 engine to achieve normal operating temperature due to its light duty cycle. As a result of this call and further investigation by the above listed entities, a thermostat was found to be malfunctioning and the thermostat was replaced. The TAC performed emissions testing after the replacement of the thermostat and found the equipment reached normal operating temperature in less time than previously recorded and the treated emissions were found to be well within the requirements of the diesel law. While the replacement of this thermostat was needed, further observations will be required to assure the problem no longer exists on the other Cummings B3.3 diesel engines in the fleet.

4-12-04

The TAC performed emissions test of the Rohmac, Microtrax that is fitted with a LPU2 Lister-Petter engine and a highly catalyzed ceramic filter. It is to be noted that this piece of equipment meets the requirement of Section 217-A in that it can be stalled for the required 5-minute emissions test. As such, the TAC had not tested this piece of equipment in its current configuration. The Bureau of Deep Mine Safety had issued the

baseline CO number for this piece of equipment. Following are the results of our testing:

- We found that even though the engine could be stalled for the required 5-minute test, the engine was not being lugged sufficiently. The CO₂ readings were in the 7.5 % range instead the normal 9 to 10% range, which indicates the engine did not achieve a lug sufficient to achieve a repeatable emissions test. The hydraulic pressure had been set at 2000psi. We believed we could achieve a better lug on the engine by increasing this pressure. Upon researching the hydraulic schematic for this engine, we found the operating pressure for this unit was listed as 2600 psi. We then contacted the equipment manufacturer and asked if it would be possible to increase the hydraulic pressure on this piece of equipment. The OEM stated the pressure could be increased to a maximum of 3000 psi with no harm to the equipment. We then had the maintenance personnel increase the pressure as we tested each setting. We found that at 2700 psi. the CO₂ readings indicated the engine was sufficiently lugged so a decision was made to allow the hydraulic pressure to remain at this setting.
- After setting the hydraulic pressure at 2700 psi , we recorded the untreated CO emissions which showed a marked improvement over the original baseline. We also notice that the filter would not regenerate even during repeated stall tests.
 - Note: The Management of Emerald Mine stated that this piece of equipment was basically unusable because of the lack of regeneration and that they had considered changing the hot gas filter configuration. We stated that the TAC would entertain such a filter change. The TAC will cover this filter change in a separate recommendation.

This completed the TAC Audit of the Emerald Mine. The TAC then moved to the Cumberland Mine for audit purposes.

Audit Review- RAG Cumberland Mine

During the period of time that we were conducting our audit, two problems that were not part of our audit, arose at the Cumberland Mine:

1. A diesel particulate filter caught fire on a 9 ton mantrip which was fitted with a Caterpillar 3304, 100 hp engine and a DST exhaust after-treatment system .It was reported that flames were observed exiting the flame arrestor.
2. DST changed the design of their M30 particulate filter and the filter in the new configuration would not fit into the current filter housing nor would it achieve an adequate seal in the housing. The introduction of this new filter was made with out properly informing the TAC, the Bureau, or Cumberland Mine personnel.

Even though these problems were not part of the audit, they took up much of the time the TAC had allotted for the Cumberland Audit. Since both of these items were investigated separately and a report submitted to the Director by the TAC on these

incidents, the following account will only deal with the findings of our Audit-Review of the Cumberland Mine.

5-13-04 The TAC conducted an audit of all applicable record books at the Cumberland Mine. The results of this audit are as follows:

- The required 100 hr. emissions test are being completed in accordance with the requirements of Section 218-A.
- The CO numbers taken as part of the required emissions testing are representative of each listed diesel engine.
- The required maintenance books have all required information listed
- Overall observation is that all records are being maintained as required by law.
- The 100 hr. emissions test books do not have the original CO baseline listed for each piece of equipment for reference. The TAC recommends that all maintenance books have the original baseline emissions numbers and date of the original baseline together with machine serial number prominently displayed on the front cover of each record book. When a machine is transferred from one mine to another, the maintenance books must go with the machine.

5-18-04 We preformed emissions test on the following pieces of equipment: The numbers listed below are the untreated CO readings unless noted otherwise:

- #5404 mantrip-9 ton-Caterpillar 3304diesel engine- 100hp @2200 rpm with DST after-treatment system
 - Baseline (untreated) 178ppm - last 100 hr test 198 ppm- actual reading 265 ppm
 - Although the actual untreated reading was higher than normal, it is well within the requirements of Section 218-(A)(13).
 - We also preformed treated emissions on this piece of equipment and found the treated CO readings(240ppm) to be out of compliance with the diesel Law. The management of Cumberland Mine responded by taking the mantrip out of service. The Management of Cumberland as well as the TAC believed the oxidation catalyst needed cleaned on this piece of equipment. This unit also emitted a high volume of white smoke when performing the test procedure. We decided to re-check the treated emissions on our next visit after the oxidation catalyst was cleaned.
- DJ03 Personnel carrier, Isuzu C240- 56hp @ 3000 rpm
 - Baseline 151 ppm - last 100 hour test 77 ppm- actual reading 159 ppm
 - The treated emissions for this piece of equipment were 58 ppm CO.
- DJ02 Personnel carrier, Isuzu C240- 56hp @ 3000rpm
 - Baseline 250 ppm - last 100 hr test 295 ppm- actual reading 443 ppm

- The treated emissions for this piece of equipment were 69 ppm CO.
- The untreated CO reading are somewhat high and would likely indicate an over fueled condition.
- DJ07 Personnel carrier, Isuzu C240 -56hp @ 3000rpm
 - Baseline 289 ppm - last 100 hr test 259 ppm -actual reading 431 ppm
 - The treated emissions for this piece of equipment were 32 ppm CO.
 - Here again the untreated CO emissions were unusually high for this piece of equipment although the emissions are within the required range of the baseline. It is interesting to note that there seems to be a difference in untreated baselines between the Isuzu engines ranging from 200-400 ppm CO. We suspect an over fueled condition causes the higher readings and suggest the Isuzu representative investigate this discrepancy.
- MLD 04- 20 ton locomotive- 3306 Caterpillar- 150hp @ 2200 rpm
 - Baseline 174 ppm - last 100 hr test 164 ppm -actual reading 272 ppm
 - The treated CO emissions were 170 ppm for this piece of equipment which is not in compliance with the diesel law. This piece of equipment was removed from service by Cumberland management for maintenance. The TAC will retest this piece of equipment at a latter date to insure compliance with the diesel law.
- After testing and visually inspecting the above listed equipment, the TAC believes that the equipment at Cumberland mine is being properly maintained. The two pieces of equipment listed above with high treated CO emissions were taken out of service immediately after the problems were detected and preparation was made to bring both pieces back into compliance with the diesel law.

5-26-04

We returned to retest the two pieces of equipment that had previously been taken out of service on our previous visit. The results of this retest are as follows:

- 5404-9 ton mantrip, 3304 Caterpillar- 100hp @2200 rpm
 - Treated emissions with new catalyst- 46 ppm CO passed
- MLD04 -20 ton locomotive- 3306 Caterpillar -150hp @ 2200 rpm
 - Treated emissions after catalyst was cleaned- 102 ppm CO failed
- After retesting the two pieces of equipment, the following equipment became available to us for testing:
 - MLD03- 20 ton locomotive -3306 Caterpillar -150hp @ 2200 rpm:
 - Untreated CO emissions -172 ppm. Treated CO emissions first test- 118ppm- catalyst is six months old. Second test installed a different cleaned catalyst dated 2000 - treated emissions-86ppm. It is to be noted that this piece of equipment has in excess of 8000 hrs of operating time with no major maintenance on the engine. The untreated CO emissions are a testament to the level of maintenance being preformed by the Cumberland mine personal.

It must be noted that Cumberland mine is experiencing a problem, at this time, with the treated CO emissions on some of their diesel equipment. We as well as

the mine personnel believe the problem to be with the oxidation catalysts. It is unclear whether the catalysts are being poisoned or if they are being coated with hydrocarbon by-products because of a light duty work cycle. Mine personnel are currently looking into this problem.

Summary

During this Audit-Review, the TAC observed some conditions that we believe need further investigation. It must be noted that the below listed items do not in and of themselves violate any section of the Pennsylvania Diesel Law; however, some of the conditions created by these items may eventually cause a violation of the diesel law if not properly addressed. Following is an explanation of our concerns with these conditions.

- **Light duty cycle:** (Diesel engine not operating at normal engine temperature of (170-180 F).

Through our observations, we have found a light duty cycle to be the cause of much of the required maintenance performed at both Emerald and Cumberland mines. This condition is not a violation of our diesel law nor can it be solved through stricter application of our diesel law but it can have very serious consequences. The TAC believes this problem can only be addressed through continued training of all parties involved in the process. Some of the causes for this condition are: diesel engines with excessive horsepower for their intended work cycle, diesel equipment that is being shifted out numerous times and not achieving proper operating temperature, large cooling systems or piping arrangements that over cool the diesel engine, older technology diesel engines that emit high quantities of hydrocarbon byproducts and/or pollute the oxidation catalyst and piping with unspent fuel . The TAC would like to consult with the agencies (MSHA & NIOSH) to acquire more information as to possible solutions to these conditions. After these consultations, we would suggest a training seminar to present our findings to the mining industry. We do not see this problem as being easy to solve; however, we do believe it can be improved upon and must be addressed.

- **Oxidation catalysts clogging and not performing as intended:**

During the time we were conducting our Audit-Review, we noticed an increase of oxidation catalysts being taken out of service because of non-compliance of the treated CO emissions requirement. A catalyst can fail if either it becomes coated with hydrocarbon by-products, which will not allow the exhaust gases to contact the platinum coating, or the platinum coating has been poisoned or removed from the catalyst's core. This condition is not a violation of our diesel law if the catalyst is taken out of service or otherwise cleaned or replaced when it is discovered. The concern is that since the catalyst is only tested once every one hundred hours of operation an ineffective catalyst could allow higher concentrations of CO in the mine air for a considerable period of time before being discovered. We also question why some catalysts perform much better than

others even though all the catalysts for a given approval are to be identical. It is our observation that they frequently perform differently and older catalysts may be more efficient than the newer catalyst. It appears that once you get a "good" catalyst it stays good for a considerable period of time. The mine operator has no control over the catalyst he receives and we believe more investigation is needed in this area in a desire to insure more consistent performance of oxidation catalysts.

- **Annual operator retraining:**

Our travels in the mines allowed us to observe an annual operator retraining session. The training session was conducted by training personnel at the mine underground at the tail track of a working section.

The trainer did a good job of completing the training in a very difficult and confined area but it raised questions in our mind as to the whether the training plan could be improved upon that would benefit both the mine operator and the employees. We recommend, for the benefit of the mine, the Bureau study with mine management the annual operator refresher training requirements in an attempt to streamline the criteria in order to improve the effectiveness of the refresher training in a manner more easily accomplished by management.

- **Equipment Requiring Additional Testing**

The Diesel equipment at the operations was found in an excellent state of repair and the TAC witnessed a conscientious effort by union and management to operate the diesel fleet in compliance with the Act. We also noted that in problem areas such as light duty cycles on the Cummins B3.3 diesel engine, differing performance of oxidation catalysts on the 20 ton locomotives in particular, and the inability of the Microtrax to operate for any length of time due to high back pressure, the operator was diligently attempting to solve these problems with little or no help from the equipment manufacturer. However, during the audit, these issues were addressed and the TAC assisted the operator in coordinating communication with the equipment manufacturer to attempt to improve upon these issues. It appears that the Cummins B3.3 and Microtrax issues may be solved but we would like to further verify this in the field with additional testing.

- **Location of the required emissions test ports:**

The emissions test ports are located in the operator's compartment or operator's station on all approved diesel powered equipment. In our travels, we have noticed that the test ports in other areas of the country are located as close to the engine as possible. This is in sharp contrast to what we are doing in Pennsylvania. We do not see the need to do away with our current configuration but we are recommending the addition of a set of secondary test ports, which should be located, as close to the engine as possible. These ports would only be used if the emissions readings from the original ports were suspect. As we have been doing numerous emissions tests in the field, it has become apparent that the original ports

are some times located too far from the engine. This will result in clogged lines and excessive amount of lag time for the exhaust gas to reach our analyzer. In addition, as we inspected the record books at both Emerald and Cumberland, we noticed recorded CO reading which, while acceptable, were very low for the engine tested and we suspect some of these readings were a result of partially clogged port lines which would not allow the proper amount of exhaust gas to reach the analyzer. We believe this topic needs to be included in any training effort that is a result of this Audit-Review.

- **Exhaust gas analyzer with multi-gas read outs:**

Section 217-A and 218-A of the Pennsylvania Diesel Law requires all underground diesel equipment to undergo emissions testing and record the CO readings, from these tests, as a means of tracking the tune of the diesel engine. This has become a universal approach for maintaining the diesel engine. In order to insure the repeatability of the emissions test results, you must also induce a repeatable load on the engine. To insure the engine has been loaded sufficiently you must know what percentage of O₂ or CO₂ is present in the exhaust during the test and you can not assume the engine is loaded to an acceptable level simply by putting it into gear. Since Pa law only requires the recording of CO emissions, we cannot be sure the engine is under an acceptable load, as stated in the law, while recording only the CO readings. We have consistently proven this in all our emissions testing a prime example of which is the Rohmac Microtrax. Even though we loaded the engine to what had been considered an acceptable condition, the CO₂ readings verified that the engine was not loaded to an acceptable level and proper loading of the engine did not occur until the hydraulic pressure was increased. This proper loading, as we have reported earlier in this document, produced lower CO readings. This does not mean that when a diesel engine is properly loaded you will always see lower CO readings, but it does mean that you will always get repeatable readings. If the engine is not loaded to an acceptable level then the CO reading will not give the intended result of being a diagnostic tool. We recommend as a "best practice" that the operator utilize a four gas instrument for their emissions testing in order to insure the engine is sufficiently lugged during the emissions testing. Also, many of the newer engines are NO or NO₂ (NOX) based engines and emit very little CO so it is imperative on these engines that the emissions testing include the NO or NO₂ (NOX) readings. Even though our diesel law does not require these gases be recorded, it would be in the best interests of the mine operators and employees to know what the concentration of these gases are in the exhaust stream of each diesel engine in order to insure that they are performing repeatable emissions testing and this additional knowledge can also serve as a diagnostic tool when problems arise with a diesel engine.

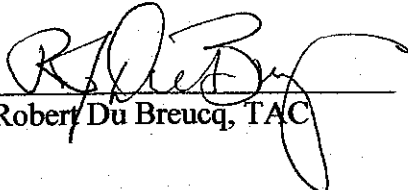
- **Industry Wide Seminar**

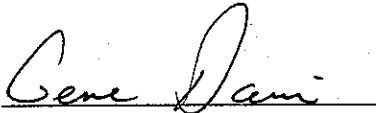
The TAC would request that the Bureau conduct an industry wide seminar for equipment manufacturers, mine operators, employees, State inspectors, and MSHA on the current status of diesel knowledge and experience. Knowledge is of

no value when it is only know by a select few and it is only of value when it is distributed to all. The TAC will assist the Bureau in this seminar if requested

• **The Pennsylvania Diesel Fleet**

We would like to report that the Pennsylvania diesel fleet is in excellent condition with high quality management and workers at each operation insuring compliance with the Act .These entities demonstrated to the TAC a conscientious desire to operate the best possible diesel fleet and the maintenance personnel exhibited considerable skill and knowledge in the performance of their duties. The few shortcomings noted in this report were not a result of the operation's failure to address the problem areas- for they were actively engaged in attempting to resolve the problem-but rather are problems for which they need assistance from the equipment manufacturers, TAC, and BDMS in order to either improve or solve the problem. All we can say to these parties is "JOB WELL DONE" and other states should be so fortunate to experience similar results. The TAC is not an expert in the diesel field but we are willing to assist any party in any effort that will improve the performance of the diesel fleet and provide a safe and healthy workplace in the Pennsylvania mines.


Robert Du Breucq, TAC


Gene Davis, TAC