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STRENGTHENING AN EXISTING 20-PSI MINE SEAL WITH PPG'S POLYUREA COATED RETROFIT

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NATIONAL INSTITUTE FOR OCCUPATIONAL SAFETY AND HEALTH
CENTERS FOR DISEASE CONTROL AND PREVENTION
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES

Strengthening an Existing 20-PSI Mine Seal With PPG's Polyurea Coated Retrofit

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Executive Summary

Analysis and testing have been completed for utilization of polyurea coating in a mine seal application to improve blast effectiveness of the mine seal. The MICON 550 seal was selected for analysis and testing for the polyurea coated modification. The baseline seal used two walls of dry stacked solid concrete blocks separated by a 16" thick polyurethane core. The unmodified seal was an approved 20 psi mine seal.

The program goal was to increase the mine seal blast pressure sustainability of a baseline 20 psi seal to greater than 60 psi. A coated retrofit design was developed for the Micon 550 seal which includes a secondary 8" thick polyurethane core, secondary block wall, and .125" thick polyurea coating. The retrofit configuration was installed and tested at the Lake Lynn Experimental Mine, and survived a blast test with a peak blast pressure of 78.5 psi with permanent displacement of one inch. A second test was conducted after reinforcement was added by bolting heavy steel angle to the floor on the outby side of the retrofit; the modified retrofit survived a second blast test with a peak blast pressure of 84.4 psi with total permanent displacement of 3 inches.

An alternative seal design was also analyzed with and without polyurea coating. A solid concrete block seal was selected for analysis. The uncoated seal was rated at 50 psi, and was predicted by the models to fail at 70 psi peak blast pressure. The coated seal was predicted to survive a minimum 90 psi blast using conservative predictions of potential coating failure.

The completed analyses and testing have shown that the PPG polyurea coating can be used to improve the blast protection of mine seal structures.

1 Introduction

Today there are an estimated 14,000 mine seals in use throughout the United States. Mine seals are a critical mining practice to protect mine workers from explosive methane gas. At the time of their installation, the mine seals were only required to protect against blast pressures of 20 psi. Recently, in response to two fatal mine explosions in which the blast pressures exceeded 20 psi, the Mine Improvement and New Emergency Response Act was enacted to increase the minimum. In July 2006, the Mine Safety and Health Administration (MSHA) raised the standard to 50 psi. On May 22, 2007 MSHA issued an Emergency Temporary Standard (ETS) which was amended in a final ruling issued on April 18, 2008. The final ruling on mine seals has a three tier approach: 50-psi overpressure when the atmosphere in the sealed area is monitored and maintained inert, 120-psi if the atmosphere in the sealed area is not monitored and is not maintained inert, and greater than 120 psi seal if a situation exists that will cause pressure piling, resulting in pressures above 120 psi. With this increase, an immediate need to improve the sustainable blast pressures of the existing 20 psi mine seals became apparent.

In response to the National Institute for Occupational Safety and Health (NIOSH) BAA: 2007-N-09921, PPG proposed the use of a high solids polyurea coating system for increased mine seal explosion protection. From the submitted proposal to NIOSH, PPG was awarded the contract to develop a cost effective, commercially available spray applied polyurea coating system that would upgrade an existing 20 psi approved mine seals to mine blast pressures greater than 60 psi.

2 Development and Testing Approach

The research program for the polyurea enhanced mine seal coupled modeling predictions from Penn State ARL and synthesis and formulation expertise from PPG. The research program had three main elements.

1. *Modeling* – Use finite element modeling to predict and recommend seal and coating design to be capable of withstanding a static horizontal pressure of 60 psi.

2. *Formulation* – Develop a flame-retardant and sprayable polyurea at 50°F with performance properties to enhance blast performance.
3. *Validation* – Test the polyurea retrofit seal at the Lake Lynn Experimental Mine with full scale blast performance.

NIOSH and PPG agreed to test the polyurea coated upgrade on a MICON 550 mine seal. The MICON 550 seal shown in Figure 1 represents a 20-psi approved seal used in coal mines. The construction of the seal and blast evaluations were conducted in NIOSH's Lake Lynn Experimental Mine (LLEM) near Fairchance, PA, during April-May 2008. The MICON 550 seal and polyurea retrofit were constructed in A-drift between crosscuts 3 and 4. Figures 2 and 3 show the location of the mine seal in the Lake Lynn Experimental Mine.

3 Polyurea Retrofit Design

The Polyurea retrofit was designed based on finite element analysis at Penn State University's Advanced Research Laboratory and coating formulation at PPG Industries' Coatings Innovation Center in Allison Park, PA. Initial modeling efforts were focused on predicting failure pressures on the MICON 550 as a baseline reference point. Even though the MICON 550 was qualified as a 20 psi approved seal, it was assumed that the failure load was higher than 20 psi for a designed safety factor. From modeling analysis of potential crack initiation stress, the MICON 550 was determined to have a predicted strength of 36 psi.

Since the stated project goal was to develop a retrofit which would increase the 20 psi mine seal blast pressure sustainability to greater than 60 psi, several design options were considered. The most promising design was to install a secondary block wall with an 8 inch polyurethane core outby of the baseline seal, and apply the polyurea coating to the secondary wall. This design approach was consistent with a retrofit environment, and provided a new and consistent surface for the polyurea coating application. The stress based failure prediction for this retrofit design was 68±10 psi, and showed highly nonlinear response at 120 psi. Based on these results, the dual core retrofit configuration was expected to survive 65 psi peak blast pressure testing at Lake Lynn Mine with low risk. Modeling and performance properties can be found in **"**Finite Element Modeling for Blast Resistant Polyurea Coatings for Mine Seals" in Appendix A.

4 Polyurea Coating Development

The polyurea coating development and optimization was completed by PPG Industries. The polyisocyanate resin (CAT137) was specifically designed for application and physical properties at 50-60°F mine temperatures as well as enhanced fire resistance per ASTM E-162. Several gallons of CAT137 were produced at PPG Coatings Innovation Center for the mine seal coatings application. The amine formulation (BDL95617B) was also developed based on performance properties at 50-60°F. The mine seal polyurea formulation had improved fire resistance but did not meet a "Class A" flame spread index of <25 according to ASTM E-162. To achieve "Class A" flame spread rating, two coats of PPG's Speedhide 42-7 (Interior Flame Retardant Flat Latex coating) were applied over the polyurea mine seal coating. Results from V-TEC testing labs showed an average flame spread index of 9.28 which is considered "Class A". Toxic gas generation test per BSS7239 was also test by V-TEC. Specific details on the polyurea coating properties and tests can be found in "Polyurea Coating Properties" in Appendix B.

5 MICON 550 Construction

The MICON 550 seal consists of two dry stacked concrete masonry units and a special polyurethane polymer and aggregate inner core. The first rows of 8-in x 8-in x 16-in solid-concrete blocks for the front and back walls were laid 16 inches apart shown in figure 4. The core thickness was determined by the height of the mine seal. From MICON's technical bulletin, a mine seal with a height of 7.3 feet requires a core thickness of 16 inches. After the first rows were constructed the remaining rows on the back wall were installed by stacking blocks in place without mortar. Once the back wall was completed the front wall was installed by stacking blocks in place without mortar. The two component polyurethane (RokLok 70) was used in the construction of the inner core to coat the floor, the interface between the block walls and floor, and the block walls and ribs within the core area (figure 5). For the initial step, Seal Lok 120 was applied in the inner core to coat the floor and 2-4 inches of aggregate was applied while the Seal Lok 120 was liquid (figure 6). Within several minutes, the polymer expanded within the aggregate. After establishing the core base, four inches of aggregate was added to the initial lift and thoroughly coated with Seal Lok 120. After 5 minutes the Seal Lok 120 reacted and expanded to about 14 inches. This step was repeated until the seal was completed to the roof (figure 7). Additional details of the seal construction procedures are in 'MICON 550 Seal Construction Description' and 'MICON 550 Technical Bulletin' in Appendices C and D. Information on the construction materials are in the 'Material Data Safety Sheet (MSDS) and Technical Data Sheets for Construction Materials' in Appendix E.

6 Polyurea Retrofit Construction

The Polyurea retrofit was installed on the outby side of the MICON 550 seal. The outby side refers to the accessible side of the seal in an actual coal mine. The first course of 8-in x 8-in x 16-in solid-concrete block was laid 8 inches +/- 1 inch in front of the MICON-550 seal (figure 8). Seal Lok 120 rigid polyurethane was used between the MICON-550 seal and the new wall (figure 9). No stone aggregate was used in the core except for a broadcast of #57 stone between lifts of polyurethane in situations where a subsequent lift was not applied while the top layer of the previous lift was still tacky. The solid concrete blocks were glued together and glued to the ribs, floor and roof with RokLok-70, rigid polyurethane (figure 10). RokLok-70 was also used to coat the interior cavity surface of the core before installation of Seal Lok 120 and around the perimeter of the glued concrete blocks.

6.1 Preparation before Coating Application

Once the concrete block wall was constructed, the wall was inspected for uniform appearance. Holes were filled with putty and excess Seal Lok 120 and RokLok-70 were removed from the wall and floor with a hammer and chisel, or equal (figure 11). Duct tape was used in some areas to bridge gaps between the seal wall and roof. Also, loose debris was removed from the wall and floor with compressed air and/or brush and swept-up with broom.

The polyurea coating was shipped in a prepackaged dual connecting 600cc cartridge (figure 12). One cartridge contained the white polyamine (BDL95617B). The other cartridge contained the clear polyisocyanate hardener (CAT137). The package also contained a static mix tube and orifice restrictor. The cartridges were prepared for application by removing the shipping collar and cap from cartridge. The restrictor was place on the cartridge so the restrictor alignment tabs fitted into the cartridge top and then the static mix tube was screwed on the cartridge.

6.2 Polyurea Coating Application

For the polyurea coating application, Personal Protective Equipment (PPE) was used at LLEM. The necessary PPE was determined by an Industrial Hygiene assessment at LLEM on Dec. 19, 2007. Detailed information on the Industrial Hygiene assessment is in the 'Polyurea Coating for Mine Seal Trial, Industrial Hygiene Sampling Report' in Appendix E. This assessment for PPE is specific to Lake Lynn Experimental Mine. Each facility or mine is responsible to evaluate its own workplace processes, conditions, and work practices to develop appropriate protective measures.

A dual 600cc canister spray gun from Plas-Pak was used for the spray application (figure 13). The spray gun was connected to a compressed air line with 100-110 psi pressure. The assemble cartridges were loaded into a dual 600cc canister spray gun by holding the spray gun in one hand, depressing piston reversing button and simultaneously squeezing trigger to retract the pistons. The trigger was released and cartridge is place securely in gun housing while keeping cartridge upright to prevent premature mixing in the static mix tube. Finally, the atomization air line was attached to the static mix tube and adjusted for 30-40 psi atomization air.

Once the dual cartridge was loaded into the gun, the polyurea coating (BDL95617B / CAT-137) was spray applied on the retrofit wall in two coats with a total film thickness between 125 to 150 mils (figure 14). The polyurea coating was also applied and tapered about 2 feet from the wall to the ribs, floor, and roof. A total of 62 dual cartridges were used in coating the seal. From start to finish, the polyurea coating application took about 2.5 hours including a 45 minute break between coats.

6.3 Speedhide 42-7 Fire Resistant Latex Coating Application

After the seal had been coated with the polyurea coating, PPG's Speedhide 42-7 fire resistant latex coating was applied over the polyurea coating with paint rollers and brushes (figure 15). The Speedhide 42-7 coating application took about 45 minutes.

The polyurea retrofit was now completed and ready for the blast test (figure 16). Additional details of the Polyurea retrofit are in the 'Polyurea Retrofit Construction Details' in Appendix F. Detailed information on the construction materials are in the 'Material Data Safety Sheet (MSDS) and Technical Data Sheets for Construction Materials' in Appendix G.

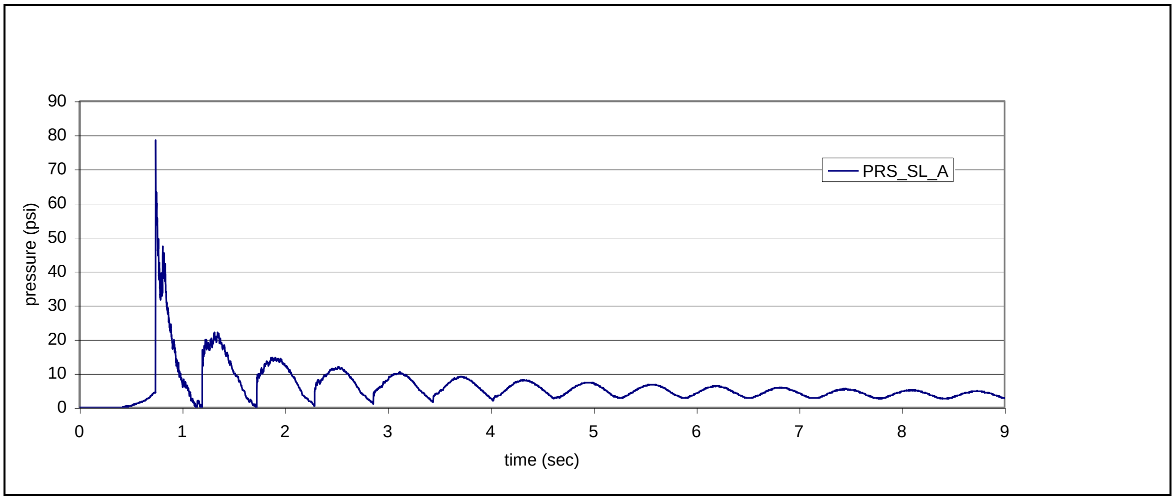
7 First Blast Test at LLEM (Test #523)

Measurements of the air leakages through the seal were taken before and after each of the explosion tests. Pre-explosion air leakage measurements on the polyurea retrofitted seal showed no detectable leakages at pressure differentials up to 4.2 in H_2O.

Location	Air Leakage Rates, CFM at pressure differential of -			
	0.8 in H2O	1.4 in H2O	2.4 in H2O	4.2 in H2O
Polyurea Retrofitted Seal in A-375	0	0	0	0

Table 1: Air Leakage measurements before the first explosion test (Pre-LLEM test 523)

The first explosion test in A drift generated an initial head on peak pressure of 78.5 psi at the A-375 seal. The retrofit seal survived the explosion test (figures 17 & 18). Detailed instructions for this test are found in 'Instructions for LLEM Explosion Tests' in Appendix H.



Graph 1: Actual blast pressure data versus time for first explosion test (LLEM test #523)

The explosion pressure data was collect with a transducer at the middle front of the seal (Graph 1) and at various locations. Two data acquisition systems were used. The National Instruments Corp system collected data at a sampling rate of 1500 samples per second and the Kinetic Systems, Inc collected data at 5000 samples per second. Pressure data was report as actual and smoothed or averaged. Additional details of the pressure data generated during test LLEM test#523 are in the 'Pressure Data for LLEM Explosion Tests' in Appendix I.

Behind the seal was a linear variable differential transducer (LVDT) mounted to the posts and attached to the A-375 seal as seen in Figure 17. The LVDT measures the movement of the seal during the explosion. From the LVDT sensor data, the retrofit seal exhibited a maximum displacement of approximately 1.5 inches. The A–375 seal exhibited a permanent displacement of about 2 inches on the floor on the inby side (figures 19 & 20). The displacement was the greatest in the middle and tapered to the sides.

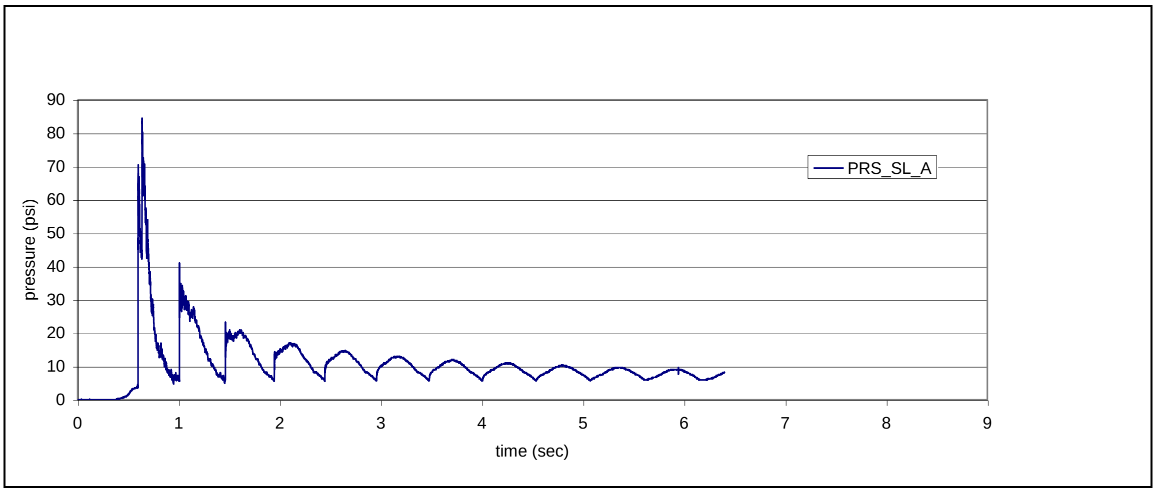
Post-explosion air leakage measurements were then collected on the seal. The A-375 seal exhibited minimal leakage when subjected to pressure differentials up to 4.4 in H_2O.

Location	Air Leakage Rates, CFM at pressure differential of -			
	0.8 in H2O	1.4 in H2O	2.4 in H2O	4.4 in H2O
Polyurea Retrofitted Seal in A-375	9.1	12.6	17.4	22.6

Table 2: Air Leakage measurements after the first explosion test (Post-LLEM test 523)

8 Second Blast Test at LLEM (Test #524)

Before the second explosion test, angle iron was installed at the base of the outby seal to prevent further movement of the seal on the concrete floor (figure 21). A second explosion test was then conducted to generate a higher pressure at the A-375 seal. Detailed instructions for this test are found in 'Instructions for LLEM Explosion Tests' in Appendix H. The second explosion test generated an initial head on peak pressure of 84.4 psi at the A-375 seal. The retrofitted seal survived the blast (figures 21 &23).



Graph 2: Actual blast pressure data versus time for second explosion test (LLEM test 524)

Additional details of the pressure data generated during test LLEM test #524 are in the 'Pressure Data for LLEM Explosion Tests' in Appendix I. Based on the LVDT sensor data, the retrofitted seal exhibited a displacement of approximately 2 inches. The seal moved an additional inch on the inby floor for a total permanent displacement of 3 inches (figure 24). The displacement was the greatest in the middle and tapered to the sides.

As listed in Table 3, post-explosion air leakage measurements revealed more air leakage compared to the first blast test.

Location	Air Leakage Rates, CFM at pressure differential of -			
	1.0 in H2O	1.7 in H2O	2.5 in H2O	4.4 in H2O
Polyurea Retrofitted Seal in A-375	17.4	26.1	34.8	53.9

Table 3: Air Leakage measurements after the second explosion test (Post-LLEM test 524)

9 Conclusions

The polyurea retrofit of a MICON 550 seal was successfully designed and model by Penn State ARL and PPG Industries. Modeling predictions determined the baseline seal performance at 36 psi and the polyurea retrofit performance at 68 psi. The actual blast tests at LLEM showed a significant improvement for blast protection with the polyurea retrofitted seal. The retrofit configuration was installed and tested at the Lake Lynn Experimental Mine, and survived a blast test with a peak blast pressure of 78.5 psi with permanent displacement of one inch. A second test was conducted after reinforcement was added by bolting heavy steel angle to the floor on the outby side of the retrofit; the modified retrofit survived a second blast test with a peak blast pressure of 84.4 psi with total permanent displacement of 3 inches. This research study has demonstrated that PPG's polyurea coating can be used to improve the blast protection of mine seals.

References:

1) Eric S. Weiss and Samuel P. Harteis, “Reinforcement of Existing Mine Seals - Evaluation of the BlastSeal Upgrade, National Institute for Occupational Safety and Health, Pittsburgh Research Laboratory, Pittsburgh, PA, May, 2007.

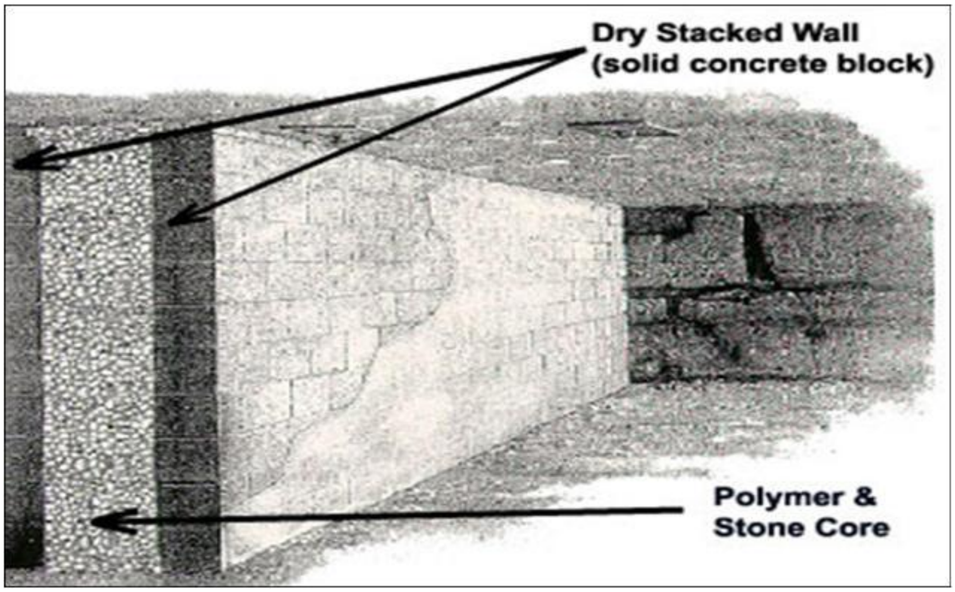


Figure 1: Schematic of MICON 550 Seal

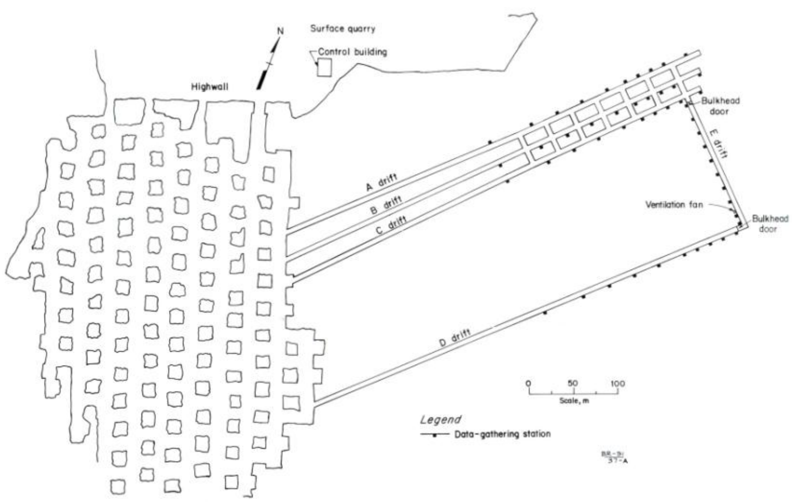


Figure 2: Plan view of the Lake Lynn Experimental Mine (LLEM).

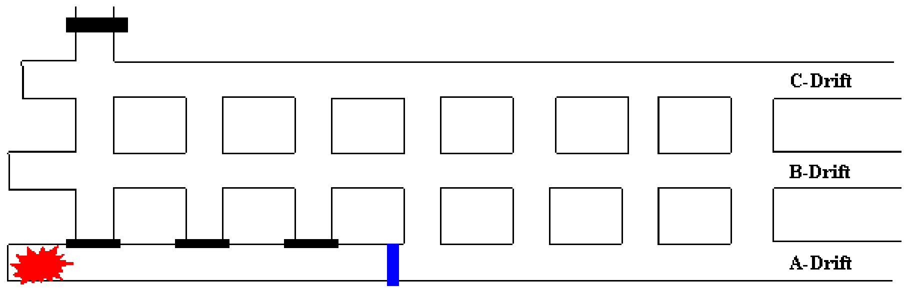


Figure 3: Mine seal test area in the LLEM

Figure 4: 1st course of concrete block for MICON 550 mine seal

Figure 5: RokLok 70 (high density polyurethane) application

Figure 6: Gravel added to RokLok 70 for MICON 550 core

Figure 7: Completed MICON 550 seal on inby side

Figure 8: 1st course of cement block for retrofit wall

Figure 9: Application of Seal Lok 120 in retrofit wall core

Figure 10: Application of Rok-lok 70 to glue blocks

Figure 11: Retrofit wall before polyurea coating spray application

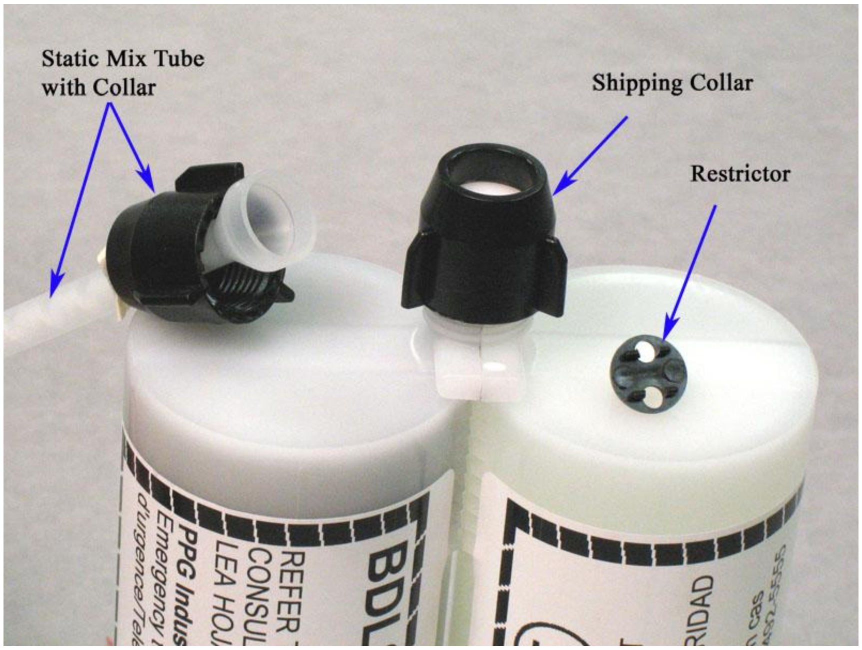


Figure 12:. Prepackaged Polyurea Cartridge with restrictor and static mix tube

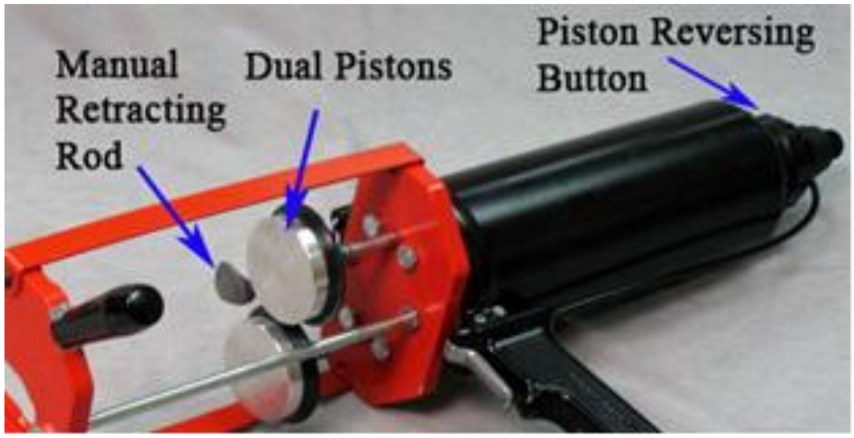


Figure 13: 600cc Dual Canister Spray Gun

Figure14: Application of PPG Polyurea with 600cc dual canister static mix gun

Figure 15: Application of PPG Speedhide 42-7 coating for fire resistance.

Figure 16: Completed polyurea retrofit seal

Figure 17: Mine Seal with LVDT sensor on outby side after 1st blast test

Figure 18: Mine seal on inby side after 1st blast test

Figure 19: Seal displacement on the inby side after first blast test

Figure 20: Seal displacement approximately 2 inches on the inby side

Figure 21: Angle iron installed on the outby face of the seal before 2nd blast test

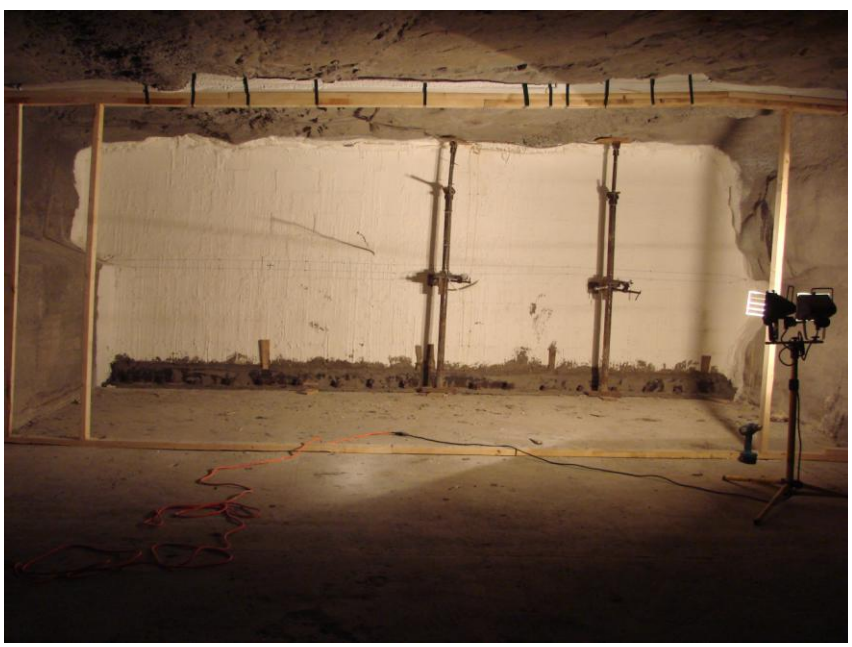


Figure 22: Mine seal on outby side after 2nd blast test

Figure 23: Mine seal on inby side after 2^{nd} blast test

Figure 24: Seal displacement approximately 3 inches on the inby side

Appendix A

Finite Element Modeling for Blast Resistant Polyurea Coatings for Mine Seals

"Finite Element Modeling for Blast Resistant Polyurea Coatings for Mine Seals"

July 20, 2008

Dr. James F. Tarter

Principal Investigator

Applied Research Laboratory

The Pennsylvania State University

PROPRIETARY NOTE

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The program goal was to increase the mine seal blast pressure sustainability of a baseline 20 psi seal to greater than 60 psi. A coated retrofit design was developed for the Micon 550 seal which includes a secondary 8” thick polyurethane core, secondary block wall, and .125” thick polyurea coating. The retrofit configuration was installed and tested at the Lake Lynn Experimental Mine, and survived a blast test with a peak blast pressure of 78.5 psi with permanent displacement of one inch. A second test was conducted after reinforcement was added by bolting heavy steel angle to the floor on the outby side of the retrofit; the modified retrofit survived a second blast test with a peak blast pressure of 84.4 psi with total permanent displacement of 3 inches.

After analysis and testing of the baseline seal, an alternative seal design was analyzed with and without polyurea coating. A solid concrete block seal was selected for analysis. The uncoated seal is rated at 50 psi, and was predicted by the models to fail at 70±10 psi peak blast pressure. The coated seal was predicted to survive 90 psi using conservative predictions of potential coating failure.

The completed analyses and testing have shown that the PPG polyurea coating can be used to improve the blast effectiveness of mine seal structures.

1 Introduction

This report is submitted to PPG industries for the project titled "Finite Element Modeling for Blast Resistant Polyurea Coatings for Mine Seals". The objective of the analyses was to complete predictions for the performance improvement of an underground mine seal which is retrofitted with PPG polyurea coating. The program goal was to retrofit an existing 20 psi approved mine seal to increase the mine seal blast pressure sustainability to greater than 60 psi. The analyses included predicting the baseline seal performance, retrofit seal performance, and comparing the model predictions to subsequent full scale testing completed by NIOSH and PPG at Lake Lynn.

After simulation and testing of the baseline retrofit, a second analysis was completed of an alternate seal with and without the polyurethane coating. The analysis methodology which was applied and validated for the baseline seal analysis was utilized for the alternate seal analysis.

2 FEA Model Approach

The analyses require prediction of mine seal performance when subjected to a highly transient blast pressure. Existing test data show typical blast events lasting on the order of 150 mS, with peak transients existing for less than 15 mS. Due to these high load rates, an explicit transient finite element analysis (FEA) method was employed. LS-Dyna was selected as the FEA solver, since it is an explicit solver and supports a wide array of geological and visco-elastic material constitutive models which were necessary for the desired analyses. Additionally, ARL/PSU has existing LS-Dyna material models which have been validated for other blast and penetration analyses. Finally, the LS-DYNA models support explicit definition of failure criteria for the various material types, which is desired for accurate simulation of the mine seal performance.

3 Analyzing PPG Polyurea Coating Using PPG/AFRL Above Ground Blast Test Results

PPG industries previously participated with the Air Force Research Laboratory (AFRL) for blast testing of an above ground concrete masonry unit (CMU) wall with PPG polyurea coating. ARL/PSU developed FEA predictions for the blast response of this wall to use as initial validation of the model approach and polyurea material constitutive models.

Figure 1 shows the ¼ symmetry FEA model of the AFRL CMU wall. Figure 2 shows the model prediction for the wall failure when subject to a transient blast with 48 psi peak pressure. Figure 3 shows a comparison of model predictions with test results for the wall failure after a full scale blast. The trends of the test data are well represented in the model. The front face fails between the cell walls, primarily at the perimeter of the wall for both the model and test. The center and back face of the wall remaining essentially intact though damaged in both the test results and model predictions.

No attempt was made to correlate the FEA model parameters to more closely replicate the AFRL results. The objective of this model was to ensure that the trends of the model predictions were accurate using baseline CMU material properties and transient blast parameters. This objective was well met with the CMU wall model predictions, and the analyses proceeded to simulation of the mine seal.

4 Finite Element Model of Baseline Seal (Micon 550)

The Micon 550 seal was selected by PPG as the baseline mine seal configuration for analysis and testing. The baseline seal consists of two rows of dry stacked 8″x8″x16″ cement blocks separated by a 16″ thick polyurethane core. This seal configuration is approved for 20 psi blast pressure at dimensions consistent with the Lake Lynn mine shaft.

Figure 4 shows the ¼ symmetry model of the baseline 550 seal including polyurethane core and dry stacked blocks. The model includes explicit simulation of each block and full contact definition and nominal gaps between adjacent blocks. Full adhesion is assumed between the blocks and the polyurethane core, side walls, floor, and ceiling.

4.1 Model Blast Pressure Definition

During testing, the blast for the explosive shock is detonated several hundred feet from the mine seal, and is estimated as a plane wave by the time it reaches the seal (no spatial pressure variation). The time varying pressure pulse is simultaneously applied on the entire blast side of the FEA models, and the transient stresses and displacement response of the mine seal are evaluated. A triangular pulse profile is assumed for the time domain variation of the applied pressure.

Figure 5 compares the assumed shape of the model triangular pressure pulse to previous Lake Lynn test data for measured pressure during seal testing as reported in reference 1. The rise time (10 mS) and linear decay time (150 mS) for the seal simulations were held constant for all model predictions, and approximate the previously measured Lake Lynn data. The peak pressure for the FEA simulations was varied to simulate varying blast loads. Since the time scale was held constant, the impulsive pressure load for the models scales linearly with peak pressure, i.e. a 60 psi simulation has 50% more impulsive pressure load than a 40 psi simulation.

After full scale testing, it was shown that the rise rate for the pressure pulse for the PPG tests was faster than the 10 mS as estimated from the previous Lake Lynn testing. A description of this difference and the impact on model predictions is provided in Section 7.

4.2 FEA Model of Hydrostatic Test Configuration to Validate Full Scale Static Predictions

A full scale Micon 550 seal had been previously tested using hydrostatic pressure on the blast face of the seal. In order to validate the baseline FEA model, the hydrostatic test configuration[1] was simulated and model predictions were compared to test results. Figure 6 shows the FEA model of the hydrostatic test configuration. The pressure load included a linearly increasing pressure on the seal face, with maximum pressure at the seal base where the hydrostatic pressure is highest. Note that a ½ symmetry model was used, since the hydrostatic pressure is not symmetric in the vertical dimension. The seal dimensions are also slightly different for the hydrostatic test model compared to the Lake Lynn configuration.

Figure 7 shows a typical displacement contour plot for the seal model subjected to hydrostatic pressure. Figure 8 shows a comparison of model predictions and test results[2] for seal displacement at the seal mid height. Since the hydrostatic load changes slowly compared to a blast load, the model comparison for this loading shows good validation of the quasi-static material properties of the model, but does not include any rate dependant validation.

4.3 FEA Model of Micon Large Scale Static Beam Shear Tests to Evaluate Polyurethane Material Properties

Micon has previously completed failure testing of their polyurethane material configured as large beam specimens. This testing provided more complete information for the polyurethane material property validation than the hydrostatic test, since it included a more controlled test environment and documented plastic loading of the beams to failure.

The test configuration for the Micon polyurethane beam shear test[3] is shown in Figure 9. This test configuration was simulated explicitly using an LS-Dyna FEA model, including full nonlinear contact between the steel plates (load application and clamping) and polyurethane beam. The nonlinear stress-strain curve and failure criteria of the polyurethane material model were then adjusted until the load deflection predictions of the model were similar to the test results. The model predictions included local failure of the polyurethane at the corners of the load application plate.

Figure 10 shows a comparison of the nonlinear load versus deflection for the model and test results for the beam shear test. The model is shown to closely match the test results for the entire load spectrum. The polyurethane stress-strain curves and failure criteria which correspond to this test were used for all subsequent blast analyses, with no strain rate hardening.

5 Polyurea Material Properties

PPG optimized the properties of the polyurea material formulation to improve the loss factor and strain-to-failure of the material at mine type ambient temperatures (~50ºF). Figure 11 shows the polyurea material curve that was used for all final analyses.

6 Model Predictions, Baseline and Retrofit Micon 550 Seal

The baseline Micon 550 seal is qualified to 20 psi peak pressure for the seal size as tested at Lake Lynn. FEA model results were desired to identify a polyurea coated retrofit design which could survive at least 60 psi during full scale testing at Lake Lynn.

6.1 Uncoated Seal Predictions

Initial model efforts focused on predicting failure pressure of the baseline uncoated seal. Although the seal is qualified to 20 psi, it was assumed that the failure load was higher than 20 psi, to allow for design margin. In order to predict failure pressure, the mine seal models were run with a variety of peak pressures to assess the change in predicted stress and deflection with increasing blast pressure. A stress based failure was identified at the blast pressure where a large enough zone of the polyurethane core had yielded to potentially initiate a failure crack. Increasing pressure was also applied to the model beyond the stress based failure pressure, to assess the pressure at which the deformation becomes nonlinear. The stressed based crack initiation pressure represents a conservative estimate of seal failure, while the nonlinear displacement versus pressure is less conservative and represents plastic failure of the seal in the absence of crack growth.

Using these criteria, the potential crack initiation stress for the baseline seal at 7’6” height was predicted at 36±10 psi, while highly nonlinear deflections in the absence of fracture were evident above 40 psi. These data constitute the model predictions for failure of the baseline uncoated Micon 550 seal. This is consistent with Micon historical data, which suggests that the 550 seal has survived non-instrumented tests of 30-40 psi in a cross-cut seal where the pressure wave is sweeping rather than head-on.

6.2 Retrofit Seal Predictions

Since the stated project goal was to develop a retrofit which would increase the 20 psi mine seal blast pressure sustainability to greater than 60 psi, design options were evaluated which could be implemented as a retrofit to the Micon 550 or other seals. The selected retrofit approach was to install a secondary block stack and polyurethane core outboard (on the non-blast side) of the baseline seal, and apply the polyurea coating to the secondary wall. This design approach is consistent with a retrofit environment, represents a feasible method for seal modification, and provides a pristine surface for application of the polyurea coating to optimize the blast mitigation effectiveness.

Figure 12 shows the ¼ symmetry model of the retrofit 550 seal including secondary polyurethane core and block stack. The model assumes a baseline Micon 550 seal, retrofitted with a secondary 8″ polyurethane core, secondary 8″ block wall with Roklok 70 joining the blocks at the mortar lines for the exterior wall only, and a .125" thick polyurea coating. The model includes explicit simulation of each block and full contact definition and nominal gaps between adjacent blocks in the baseline seal region. Full adhesion is assumed between the blocks and the polyurethane core, side walls, floor, and ceiling. The out-by block wall is assumed as a solid structure, since the Roklok 70 joining the blocks has higher strength than the blocks.

Varying secondary core thicknesses were evaluated for the retrofit seal. As previously described, the true failure pressure for the seal is a function of whether or not unstable crack growth propagates through the seal. Based on model predictions, a 4″ secondary core thickness will result in highly nonlinear seal displacements at 60 psi. This did not provide sufficient design margin for the seal testing. A 12″ secondary core thickness results in stress based failure of the seal above 60 psi and deflection based failure predictions above 120 psi. While this is the most conservative failure prediction, it was considered too conservative for the planned testing. An 8″ secondary core results in stress based failure prediction at 68±10 psi. Given the 60 psi design goal, this was selected as the best design to present acceptable design risk while representing a feasible retrofit option.

Figure 13 shows a typical displacement plot for the retrofit seal subjected to an 80 psi peak blast pressure. Local failure is shown at the edges of the individual blocks. The entire seal is deflecting as a unit, with maximum deflection near the seal center.

Figure 14 shows a typical stress plot of the polyurethane core. High stresses in the polyurethane are shown where the core interfaces with the edges of the dry stacked blocks.

Figure 15 shows a summary of the predicted blast performance for the baseline and retrofit seal configurations with increasing blast pressure. Both seal models assume 8″ block thickness. As indicated on the figure, potential crack initiation stress for the baseline seal at 7'6" height is indicated at 36±10 psi, while highly nonlinear deflections in the absence of fracture are evident above 40 psi. The retrofit seal is predicted to potentially initiate fracture at 68±10 psi, and shows highly nonlinear response at 120 psi. Based on these results, the dual core retrofit configuration was expected to survive 65 psi peak blast pressure testing at Lake Lynn with low risk.

7 Comparing Model Predictions to Full Scale Test Results, Retrofit of Micon 550 Seal

The retrofit seal configuration with 8″ secondary core and polyurea coating was installed and tested at Lake Lynn mines. The seal performed as predicted, and survived a peak blast pressure of 78 psi. There was a release of the interface between the seal and the mine floor, but the Lake Lynn installation had much less mechanical interlocking at the floor than a typical mine installation. There was no significant seal leakage after the test. A restraining angle iron was installed on the floor at the out-by side of the seal after the first test, and a second test was completed at peak pressure of 84 psi. Again, the seal survived without significant leakage.

The rise time for the blast pressure profile of the Lake Lynn testing was faster than the 10 mS rise time which was used for baseline simulations. Baseline simulations were based on smoothed blast data from LLEM. The following sections describe the actual blast signal, and the effect on model predictions.

7.1 Differences in Lake Lynn Blast Pressure Profile versus Assumed Triangular Wave

Full scale underground blast testing of the retrofit seal was completed at Lake Lynn. The rise time for the test pressure pulse (<2 mS) was much faster than previous analysis assumptions (10 mS), resulting in a higher initial blast impulse than anticipated.

For the blast load on the mine seal, the seal dynamic response is governed primarily by the first mode of the seal. This is due to two factors: 1) the first mode shape of the seal is similar to the deformed shape of a pressure loaded seal, so there is high modal coupling between the seal first mode and the blast impulse load, and 2) displacements for a given dynamic load are inversely proportional to the square of the mode frequency, so higher frequency modes naturally have lower contribution to the seal total displacement. Therefore, insight into the expected seal response can be gained by representing the seal dynamic response as a simple sine wave with frequency equal to the first mode frequency.

The frequency of the first mode of the retrofit seal is 65 Hz. If the seal dynamic response is represented as a simple sine wave which cycles through one period in 15 mS (1/65 Hz), the maximum displacement energy for a blast impulse is imparted to the seal during the first 7.5 mS when the sine wave is positive, the pressure reaches its maximum value, and the displacement and pressure load are acting in the same direction. Therefore, the total blast impulsive load which is imparted to the seal during the first 7.5 mS is critical to correctly predict the seal dynamic response.

Original model predictions assumed a 10 mS rise time for the blast pressure, followed by a 150 mS linear decay. As previously described, this time domain profile was based on blast curves which were provided from previous retrofit mine seal testing. After completion of the PPG tests, a clarification was given explaining that the previously provided blast profiles were from smoothed data. Unsmoothed and smoothed data were given to PPG by NIOSH in a data disc early in the project. The time domain profile of the blast pressure does not significantly affect the comparative design studies between different seal options, but it does significantly affect the absolute value of the predicted failure pressure. Figure 16 shows a comparison of the baseline linear model pressure with 10 mS rise time compared to the actual test results for the PPG retrofit seal NIOSH test 523. The test results show a <2 mS rise time and transient peak pressure of 78 psi, compared to 10 mS rise time and 60 psi peak pressure of the model.

The pressure impulse is calculated as the area under the curve of the pressure-time plot. Due to the rapid rise rate of the test pressure, the initial test pressure impulse is significantly larger than the original model assumptions using 10 mS linear rise. For longer time data, the test and model pressure impulse become similar as the contribution of the early rise time becomes a progressively smaller proportion of the total impulse. Figure 17 shows the ratio of the test impulse to baseline model impulse as a function of time for test 523. Using the sine wave estimate of the seal dynamic response, the test impulse is 2X higher than the baseline model assumption at the critical half period time.

7.2 Updated Model Predictions using Lake Lynn Blast Profile

In order to estimate the effect of the faster pressure rise time in the models, a series of simulations were completed with both the baseline Micon 550 seal and the PPG retrofit using a 1 mS pressure rise time, and linear pressure decay. Figure 18 and Figure 19 show the pressure versus time plots for the baseline and modified model inputs, respectively. For the first 7.5 mS (half period) of the seal response, the modified pressure input results in a factor of 1.8 increase in pressure impulse.

As with previous simulations, the mine seal models were run with incrementally increasing peak pressure to assess the change in predicted maximum stress and deflection with increasing blast pressure. The blast time was held constant for all simulations, so the impulse of the simulations scales linearly with the peak pressure. A stress based failure is assumed at the blast pressure where a large enough zone of the polyurethane core has yielded to potentially initiate a failure crack. Increasing pressure was also applied to the model beyond the stress based failure pressure, to assess the pressure at which the deformation becomes nonlinear. The crack initiation pressure represents a conservative estimate of seal failure, while the nonlinear displacement versus pressure is less conservative.

Figure 20 shows a comparison of the predicted seal response for the baseline versus high rise rate pressure profiles. Results are shown for both the baseline Micon 550 seal and PPG retrofit seal. As indicated on the figure, potential crack initiation stress for the baseline seal at 7'6" height with the new pressure profile is indicated at 30±10 psi, while highly nonlinear deflections in the absence of fracture are evident above 40 psi. The retrofit seal is predicted to potentially initiate fracture at 65±10 psi, and shows highly nonlinear response above 85 psi. Based on these results the dual core retrofit configuration is predicted to survive 65 psi peak blast pressure testing at Lake Lynn, but with lower design margin than previous analyses using 10 mS pressure rise time.

The completed analyses provide credible prediction of the full scale seal performance. Although the test seal adhesion to the floor released during testing, the retrofit seal survived the blast pressure as predicted by the models. Additionally, the analyses show the potential sensitivity of the seal performance to changes in the pressure rise rate. This underlines the importance of fully quantifying the expected blast pressure time history when assessing seal design performance.

7.3 Comparing Predicted Displacements to Test Results

As previously described, the test hardware released from the floor at the floor joint and displaced plastically an inch or more. As seen in Figure 20, the model predictions are relatively linear below 100 psi peak pressure. Therefore, the model and test data displacements can be compared for the linear portion of the displacement, but are not meaningful once the test hardware releases from the floor and begins to deform nonlinearly.

Figure 21 shows a comparison of model and test displacements versus time. The model and test results are shown to match closely during the relatively linear portion of the displacement. The time of peak displacement for the model corresponds almost identically to the change in slope in the test results from a linear response to presumed nonlinear sliding. Based on these results, the dynamic response of the model matches the test data very well.

8 Model Predictions, Alternate Seal with Polyurea Coating

After analysis and testing of the baseline seal, the validated analysis methods were applied to an alternate seal configuration to assess the expected design performance using the polyurea coating on a different seal design. The alternate seal for analysis was selected by PPG and approved by NIOSH, and is shown in Figure 22. The unmodified seal is an MSHA approved 50 psi concrete block seal (#50-75.336.1.07.01.0). Block and mortar strengths used in the analysis were based on required strengths from the 50 psi concrete block seal specification.

A ¼ symmetry model of the unmodified alternate seal was developed, including explicit simulation of each block and mortar joint. Figure 23 shows the baseline finite element mesh. Figure 24 shows the mortar joints of the mesh. Explicit simulation of the mortar joints is important to properly predict potential failure propagation along the mortar joints, which have 33% lower strength than the blocks. As with the baseline 550 model, the pressure was applied on the inboard face as a triangular wave with 10 ms rise time, 150 ms decay time, and varying peak pressure for linearly scaling impulse. The boundary conditions at the floor and wall were assumed fixed. Failure criteria and element erosion were disabled for the first several rows of elements near the boundaries, to prevent prediction of unrealistic failure modes near the fixed boundaries.

Since the alternate seal is all concrete blocks and mortar, there is no gradual change in the performance with increasing pressure as is seen in the baseline 550 displacement versus pressure plots, i.e.; the failure is more brittle and instantaneous. Therefore, a failure criterion for the alternate seal was selected wherein a crack which penetrates the entire thickness of the seal is considered a failure, since it is assumed that a fully cracked seal will no longer meet leakage requirements.

Figure 25 shows the predicted cracking in the alternate seal with increasing peak blast pressure for 60, 70, and 80 psi blast. The cracks occur in the model when the stress exceeds the confined compression strength of the block or mortar. The mortar unconfined compressive strength (1800 psi) is lower than the block strength (2400 psi), so most of the cracking occurs along the mortar joints. A crack is shown to exist for the 60 psi blast, but the crack does not penetrate the entire thickness of the seal. The 70 psi blast results show a crack which penetrates the entire seal thickness, but the seal is still intact. The 80 psi results show a crack which penetrates the entire thickness, and a significant portion of the seal has failed along the mortar joints. Based on these model results, a peak failure blast pressure of 70±10 psi is predicted for the uncoated seal.

A ¼" thick polyurea coating was added to the non-blast side of the model, and the analyses were repeated with identical blast loads. For the coated seal, no failure mode was predicted by the models wherein a large section of the seal dislodged at high pressures similar to the 80 psi uncoated condition. Therefore, failure was estimated when sufficient cracks exist through the seal thickness to expect the blocks to dislodge and potentially fail the polyurea coating leakage capability. This is the most conservative estimate of coating failure. As shown in Figure 26, the seal has no through cracks at 70 psi, has no cracks through the coating and relatively small displacements near the partial cracks at 90 psi, and begins to show proportionally larger displacements near the boundaries and cracks for a 110 psi blast. Using these results, a minimum sustainable blast pressure of 90 psi peak is predicted for the coated seal, resulting in a 40 psi improvement over the nominal 50 psi rating with the coating.

9 Conclusions

Modeling and testing have been completed which demonstrate the effectiveness of PPG polyurea coating to improve the survivability of mine seal structures in a blast environment. The completed analysis and testing of the retrofit for the Micon 550 seal show good agreement between model predictions and testing. Performance improvement of greater than 60 psi over the baseline seal qualified pressure and greater than 40 psi over the predicted baseline seal performance were shown by the models and demonstrated via testing with the retrofit design. An alternate seal was also analyzed and showed a minimum 40 psi improvement using coating only.

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[1]Sapko MJ, Weiss ES, Harteis SP [2005]. Methods for Evaluating Explosion Resistant Ventilation Structures. In: Proceedings of the Eighth International Mine Ventilation Congress, The Australian Institute of Mining and Metallurgy, Brisbane, Australia, July 6-8, 2005, pp. 211-219.

[1]Dolinar DR, Sapko MJ, Harteis SP [2008]. Performance of a Polyurethane Core Seal Tested in a Hydrostatic Chamber. Pittsburgh, PA: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2008-129, RI 9674.

[2]Dolinar DR, Sapko MJ, Harteis SP [2008]. Performance of a Polyurethane Core Seal Tested in a Hydrostatic Chamber. Pittsburgh, PA: U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control and Prevention, National Institute for Occupational Safety and Health, DHHS (NIOSH) Publication No. 2008-129, RI 9674.

[3]Sawyer S [2007]. Direct Shear Tests to Establish an Allowable Shear Strength for MICON's MPG 550-10 Polyurethane. MICON Propriety Report #21-255-07-SA.

Eric S. Weiss and Samuel P. Harteis, “Reinforcement of Existing Mine Seals - Evaluation of the BlastSeal Upgrade, National Institute for Occupational Safety and Health, Pittsburgh Research Laboratory, Pittsburgh, PA, May, 2007.

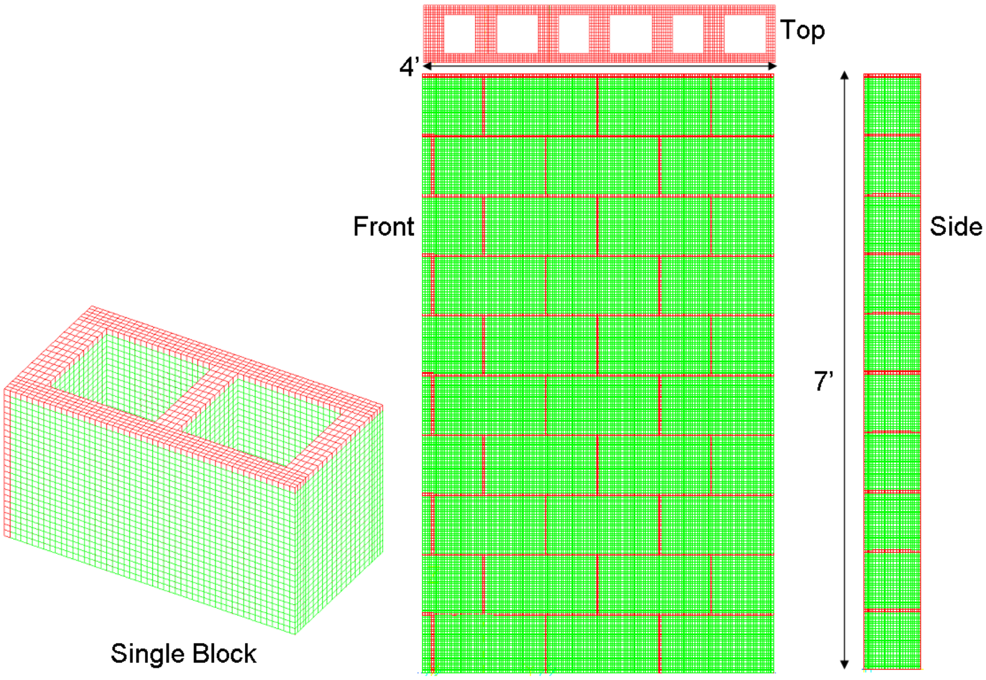


Figure 1. ARL/PSU ¼ Symmetry Finite Element Model of PPG/AFRL CMU Wall Subject to Above Ground Blast Loads. Individual CMU Blocks and Mortar Joints Explicitly Modeled

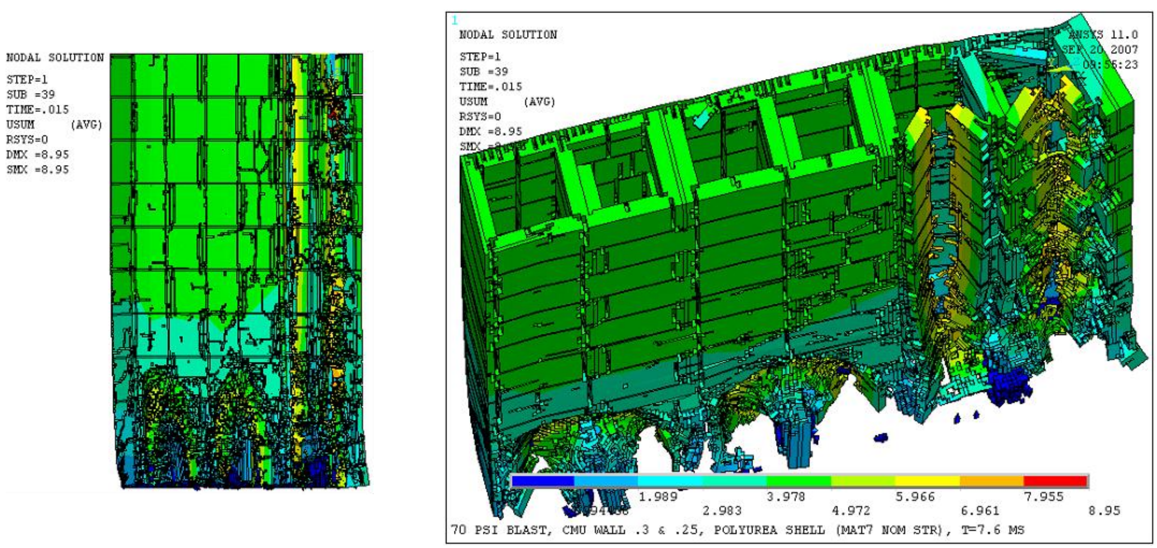


Figure 2. ARL/PSU ¼ Symmetry Model Prediction of CMU Wall with Polyurea Coating Subject to Blast Load

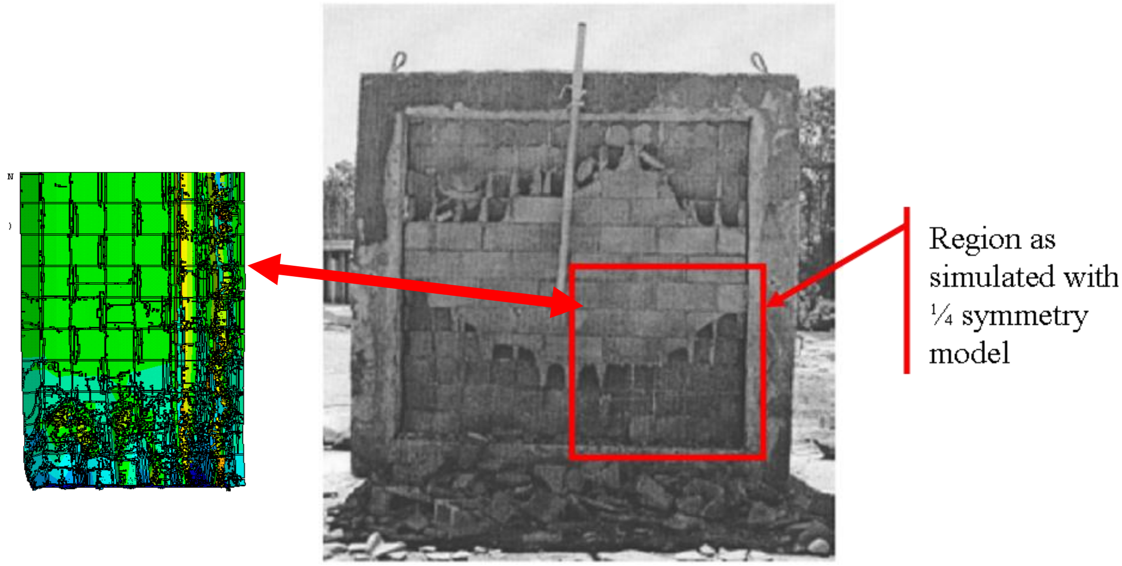


Figure 3. Comparing Explicit FEA Model Predictions to Test Results for AFRL CMU Wall with Polyurea Coating

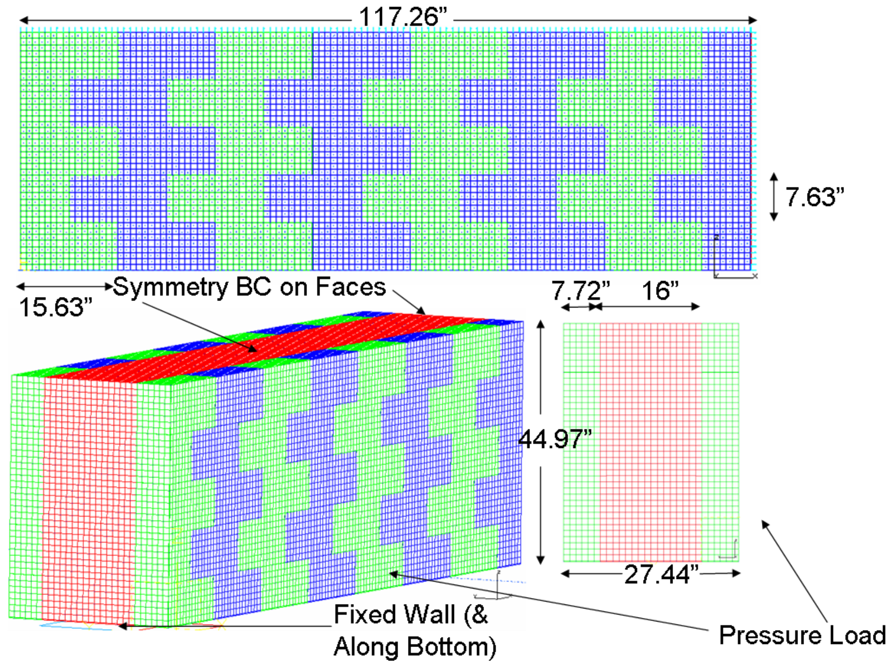


Figure 4. Finite Element Model of Micon 550 Seal, ¼ Symmetry Model. Each Block Individually Modeled with Nonlinear Contact Between Adjacent Blocks. Blocks Bonded to Face of Polyurethane Core.

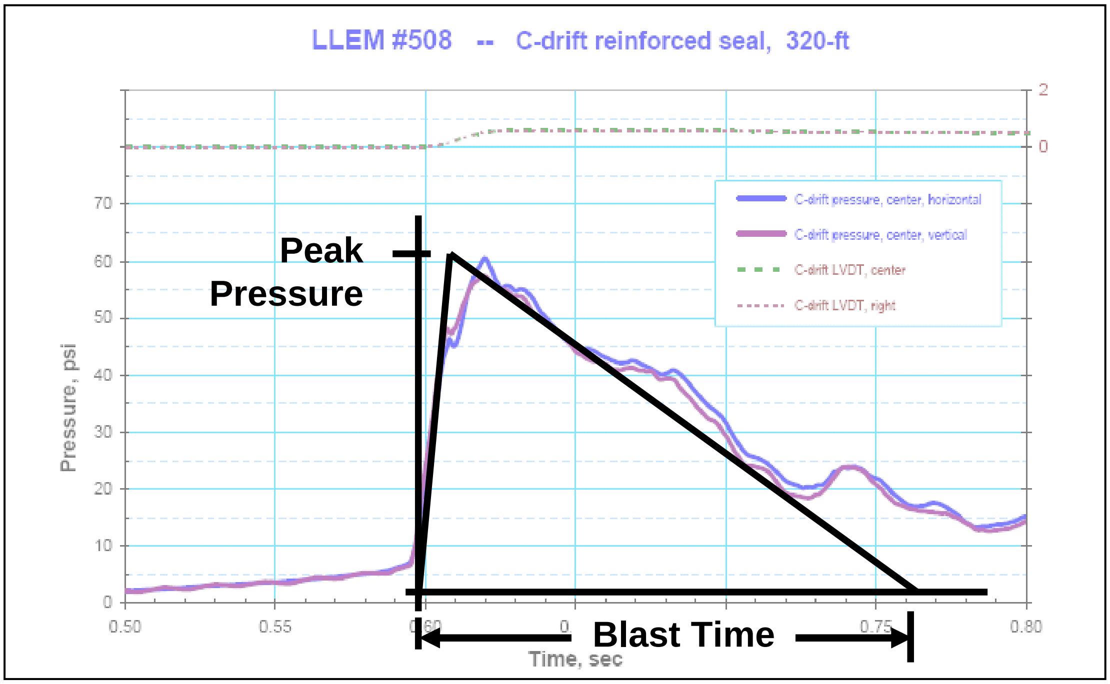


Figure 5. Comparing Model Triangular Pressure Pulse Shape with Smoothed Test Data from Lake Lynn (ref 1). Varying Peak Pressure Used for Simulations

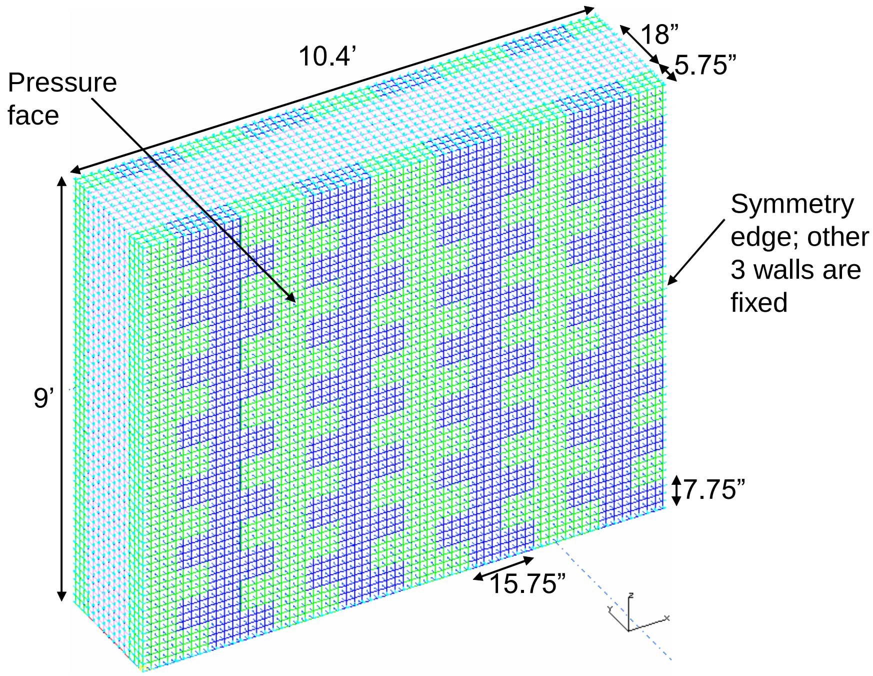


Figure 6. Finite Element Model of Hydrostatic Test Configuration, Micon 550 Seal, 1/2 Symmetry Model.

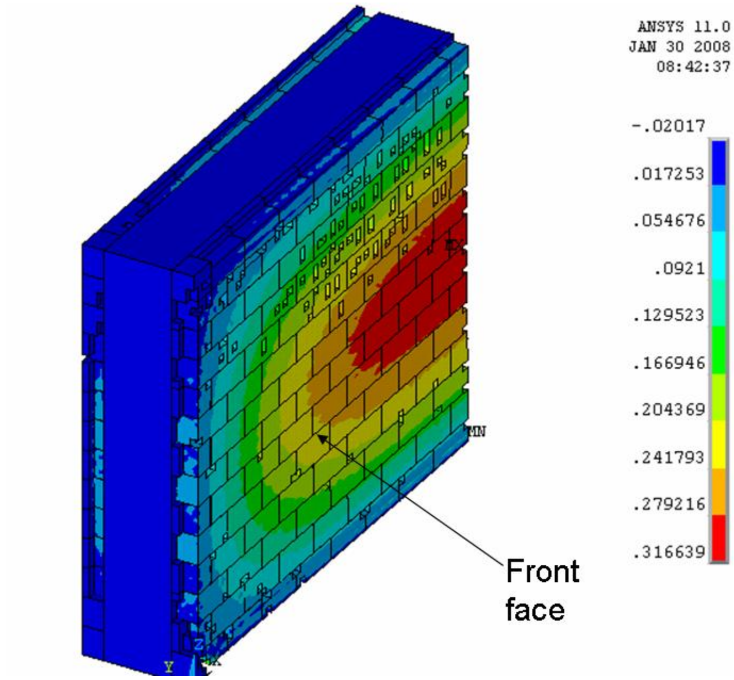


Figure 7. Typical Finite Element Result, Maximum Deflection, Hydrostatic Test Configuration, Micon 550 Seal, 1/2 Symmetry Model.

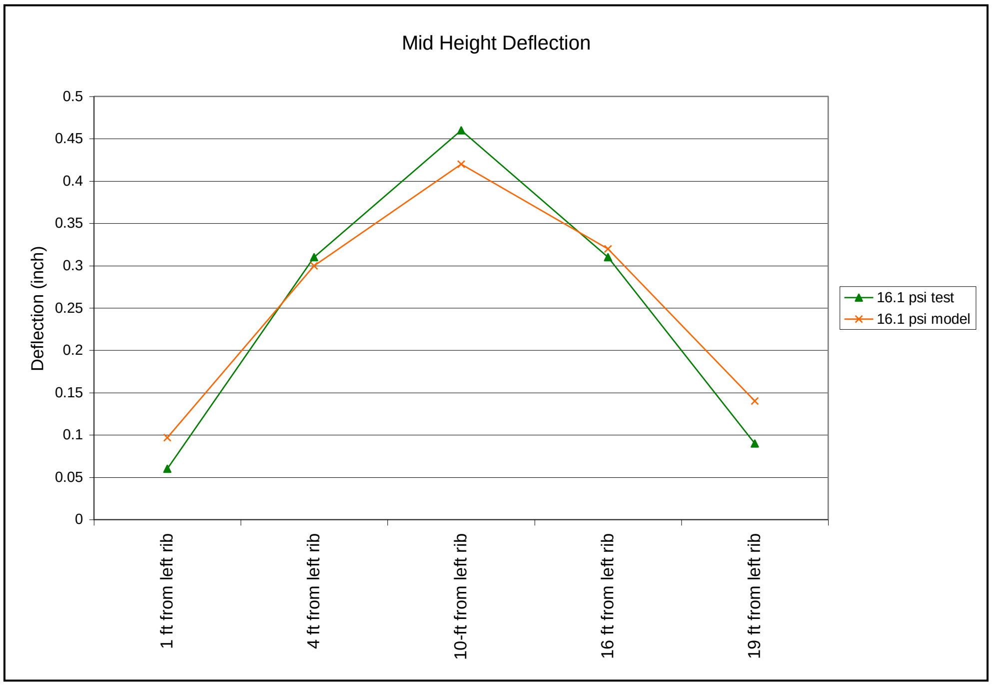


Figure 8. Comparing Finite Element Results to Test Data, Centerline Deflection, Hydrostatic Test Configuration, Micon 550 Seal, 1/2 Symmetry Model.

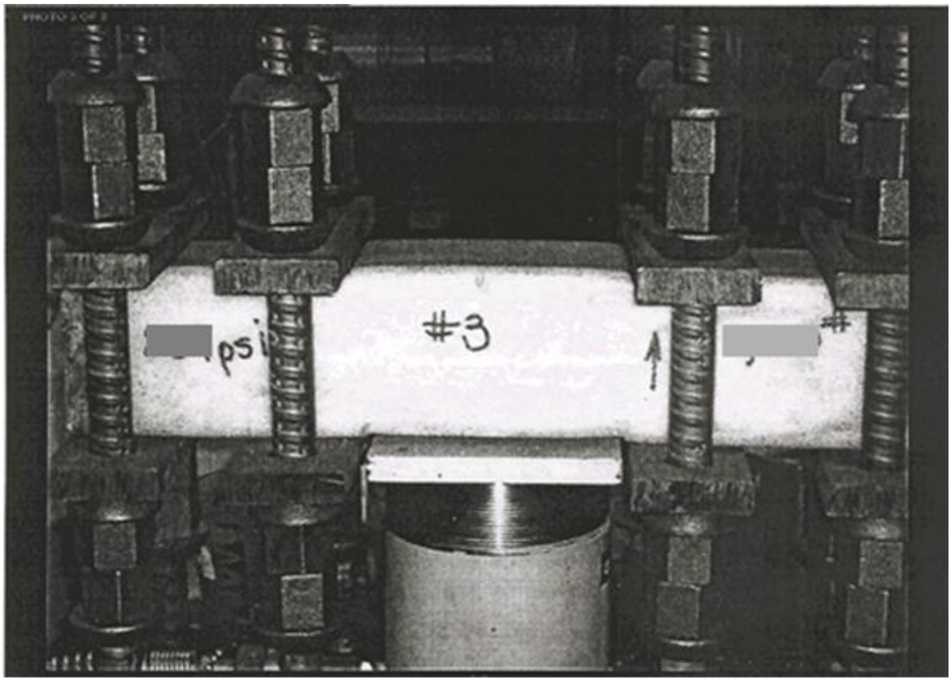


Figure 9. Micon Shear Test of Polyurethane Beam Specimen

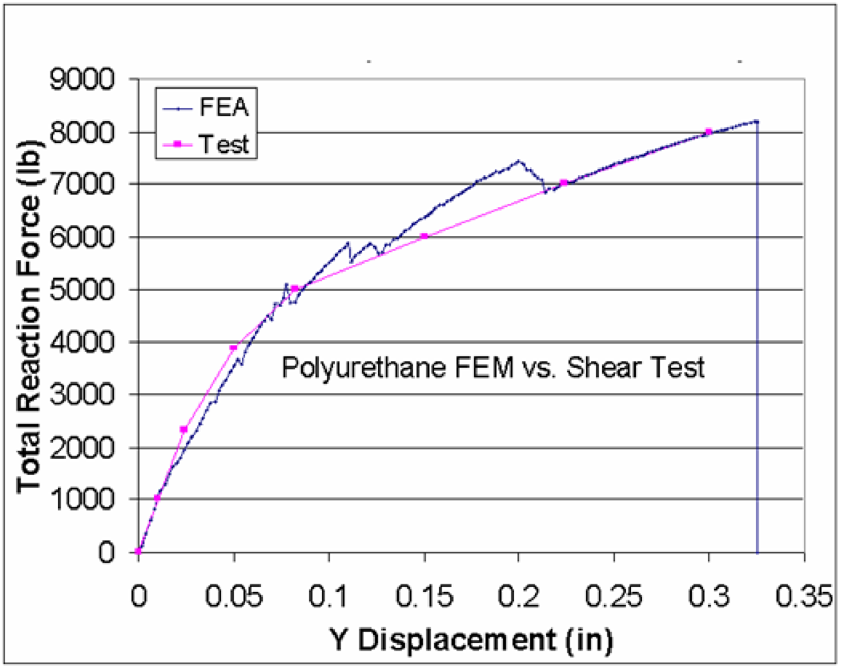


Figure 10. Comparing FEA Model Results and Test Data for Micon Shear Test, Nonlinear Contact Beam Specimen Model with Failure Criteria

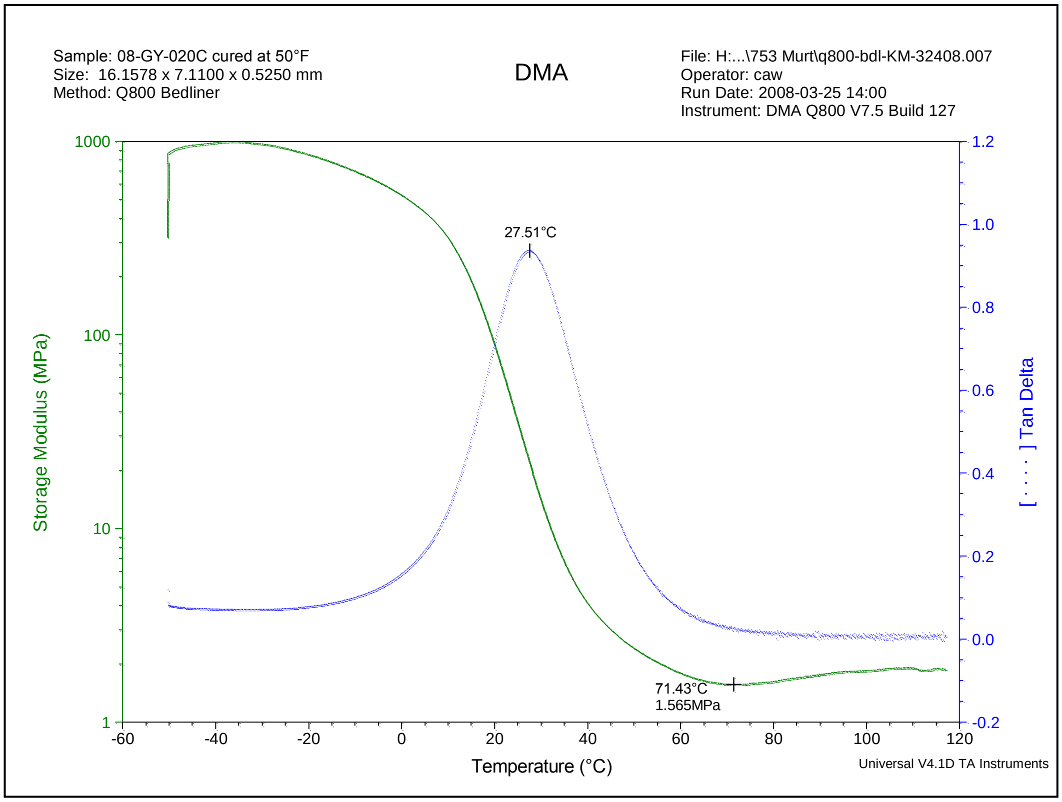


Figure 11. Polyurea Material Properties

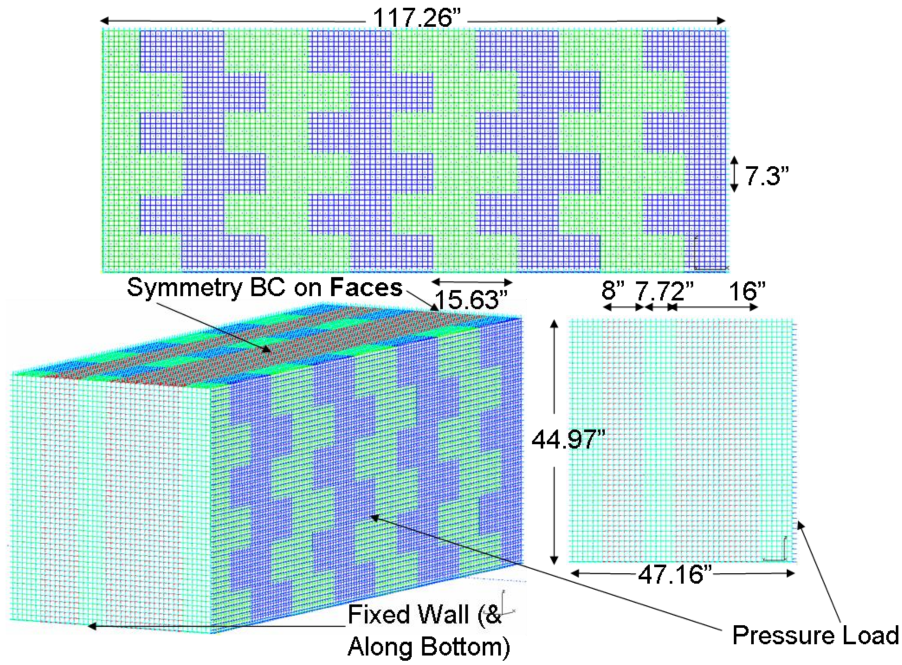


Figure 12. Finite Element Model of Retrofit Seal, 8″x8″x16″ Block , ¼ Symmetry Model. Each block individually modeled with nonlinear contact between adjacent blocks on pressure face (in-by) and interior wall. Solid mortar joints assumed for exterior (out-by) wall. Blocks bonded to faces of polyurethane cores.

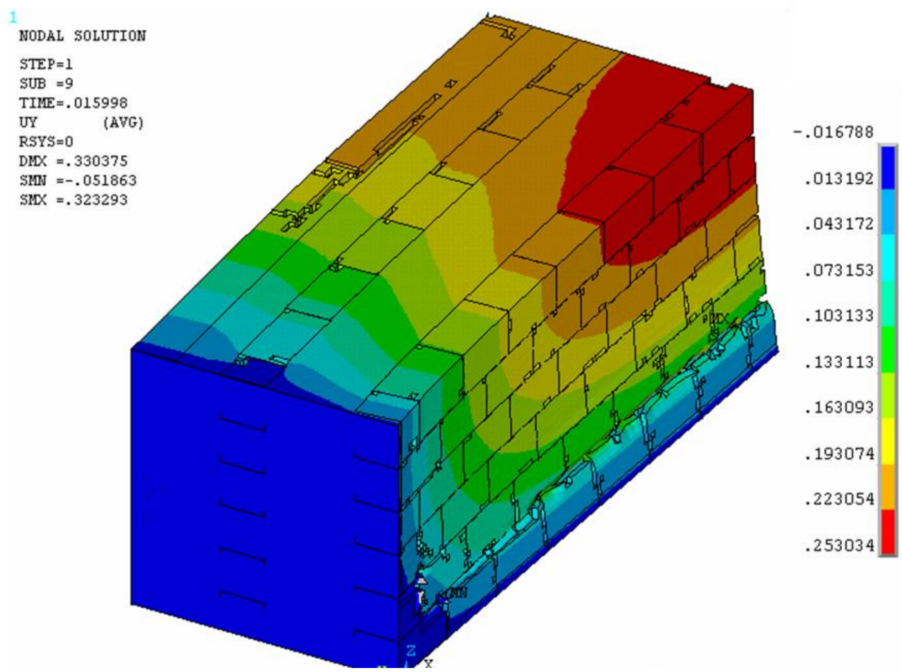


Figure 13. Typical Retrofit Seal Configuration Seal Maximum Displacement with Local Block Failure, 80 psi Peak Blast Pressure (deformation scale exaggerated)

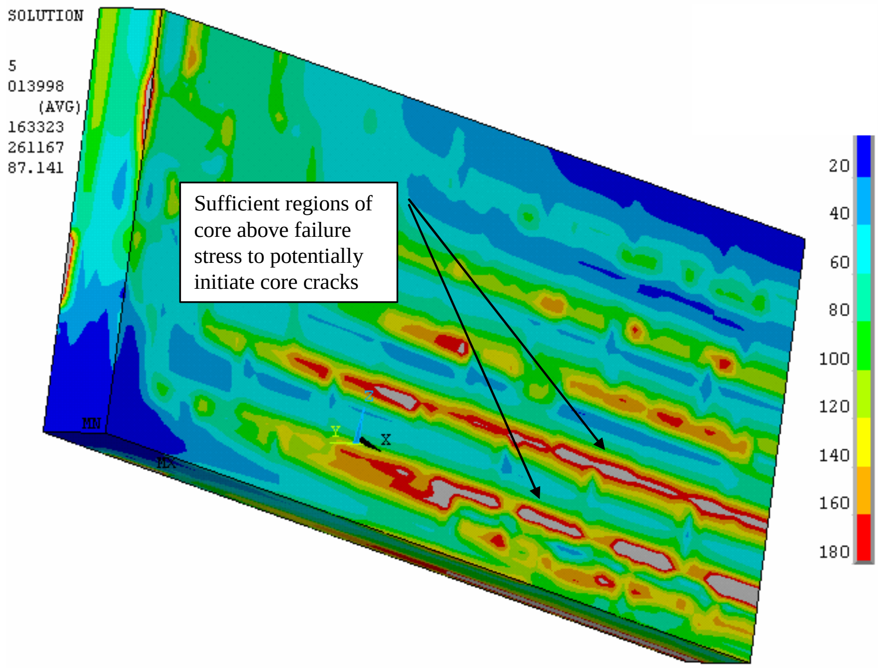


Figure 14. Sufficient Stress Shown in Core to Potentially Initiate Core Cracking

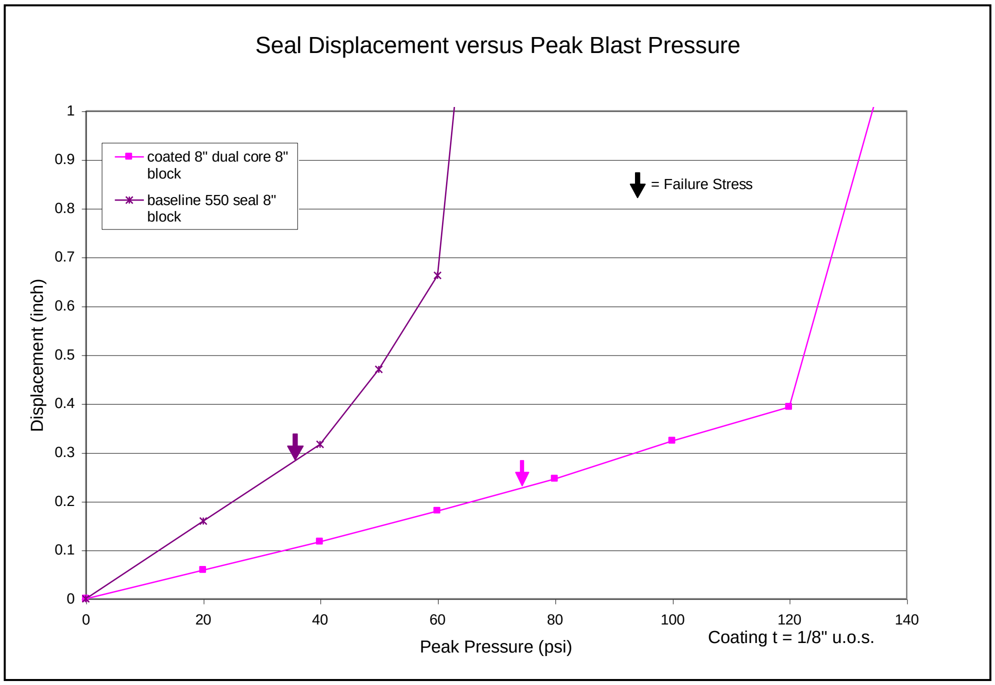


Figure 15. Mine seal FEA blast performance predictions, deflection versus peak blast pressure. Arrows show peak blast pressure where seal core exceeds failure stresses in sufficient region to potentially initiate fracture of the seal core. Curves show onset of large scale plastic deformation of the seal core if fracture does not occur.

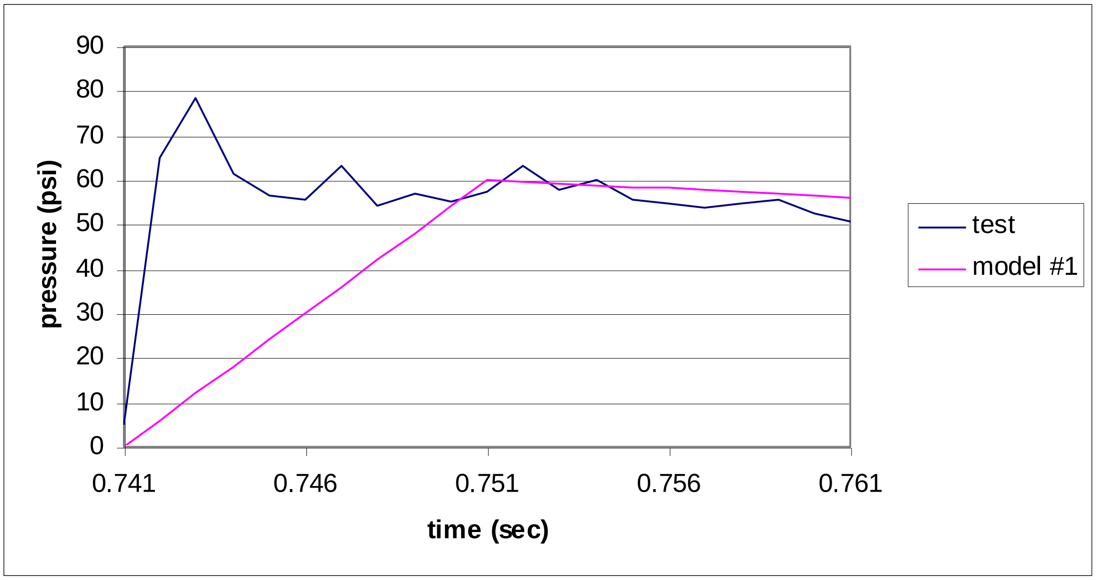


Figure 16. Comparing baseline linear model pressure pulse to actual test pressure for first 20 mS of NIOSH test 523.

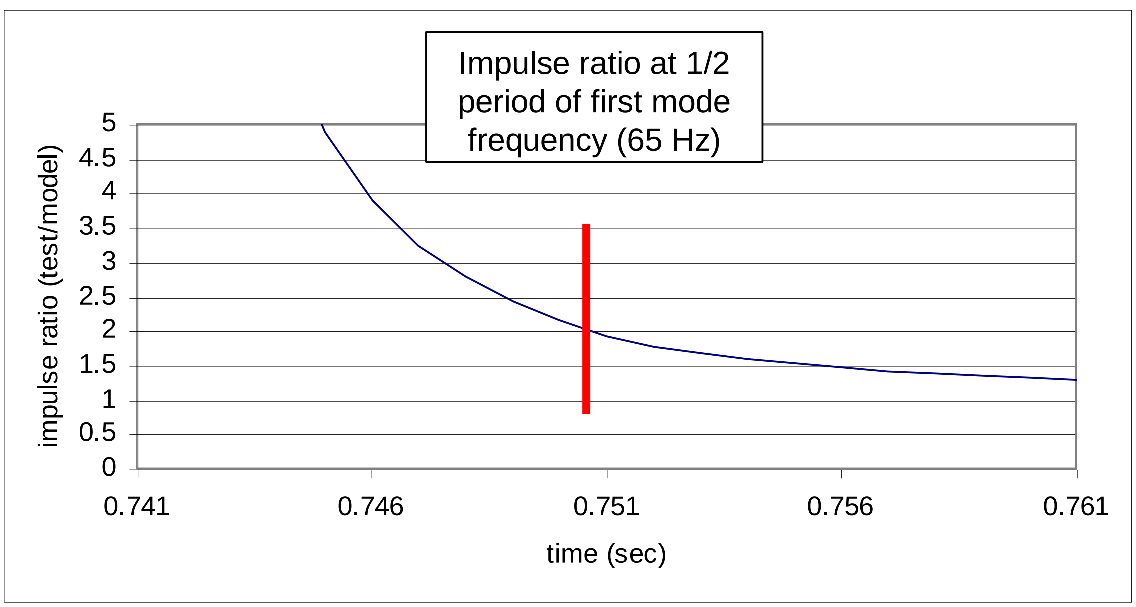


Figure 17. Ratio of test 523 impulse to model impulse with 10 mS linear rise time.

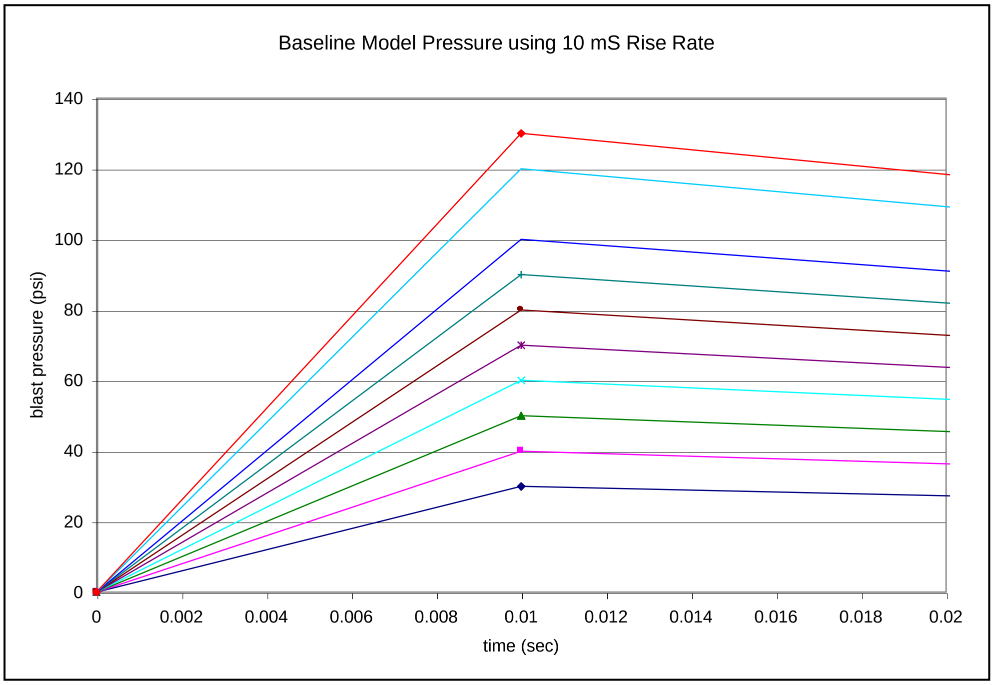


Figure 18. Original Model Pressure Inputs, 10 mS Rise Time, Varying Pressure Peak

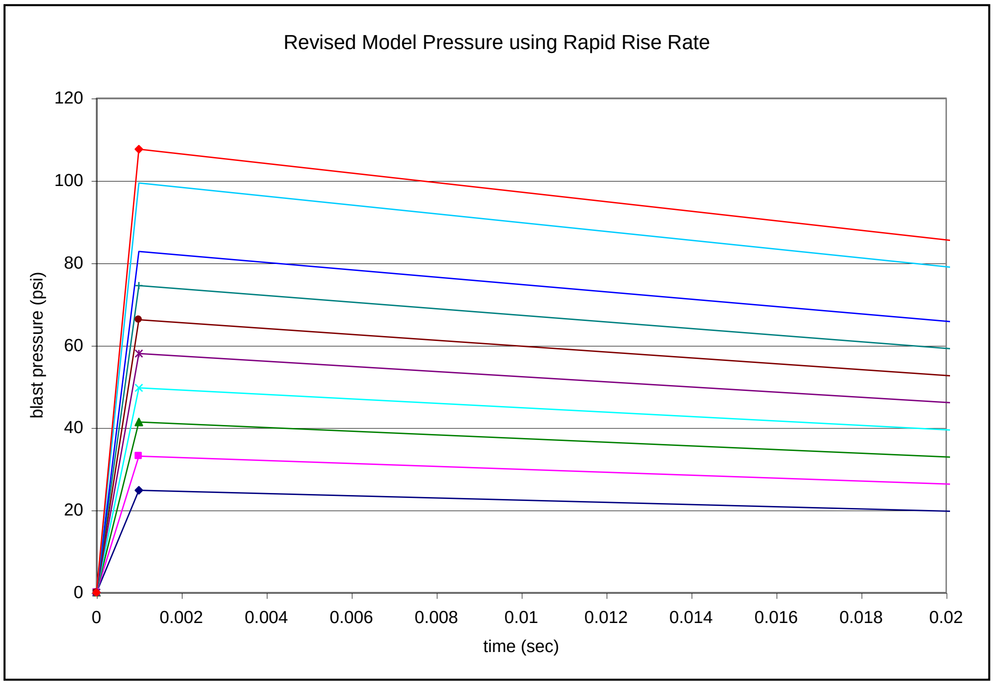


Figure 19. Revised Model Pressure Inputs, 1 mS Rise Time, Varying Pressure Peak

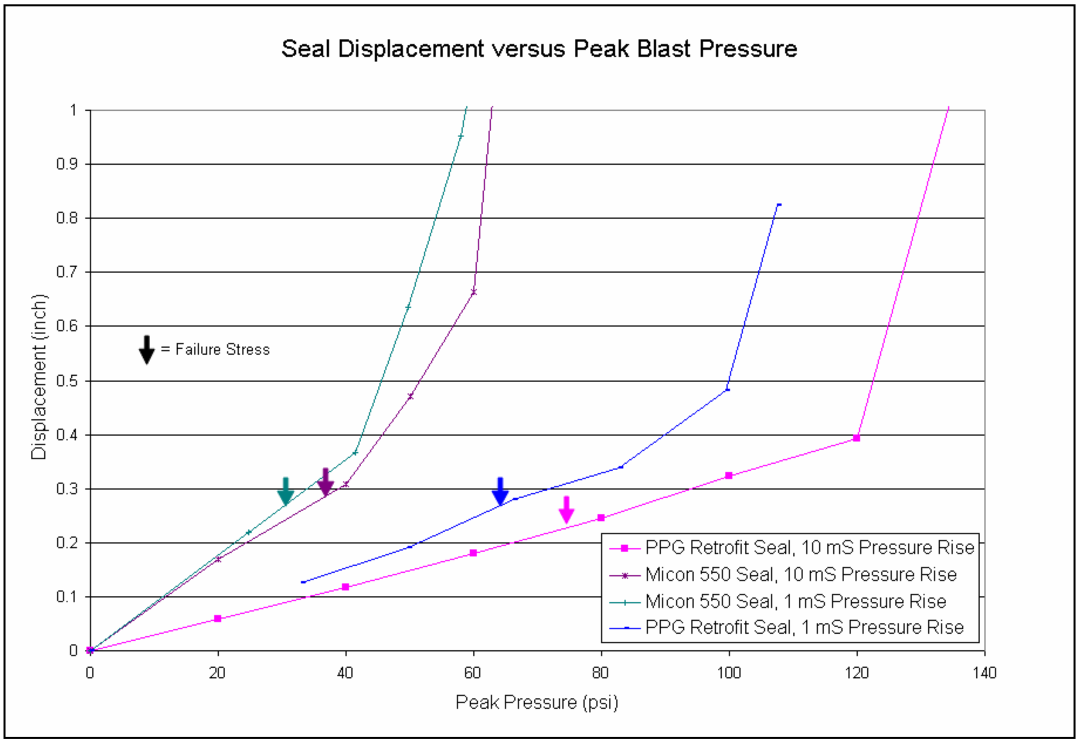


Figure 20. Comparing Predicted Seal Deflection versus Peak Blast pressure for Micon 550 and PPG Retrofit Seals, Using 10 mS versus 1 mS Pressure Rise Rate. Arrows show peak blast pressure where seal core exceeds failure stresses in sufficient region to potentially initiate fracture of the seal core. Curves show onset of large scale plastic deformation of the seal core if fracture does not occur.

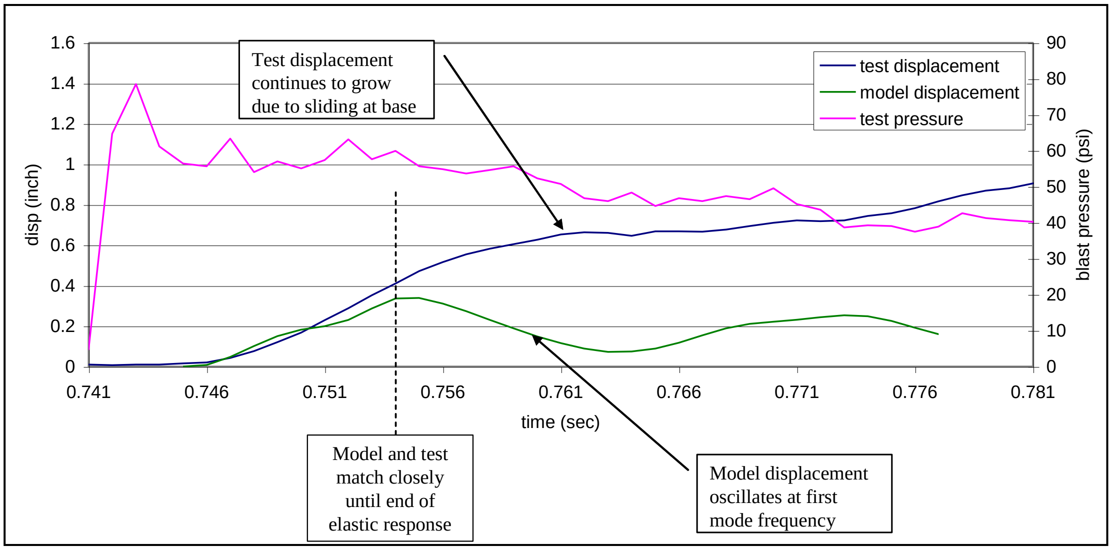
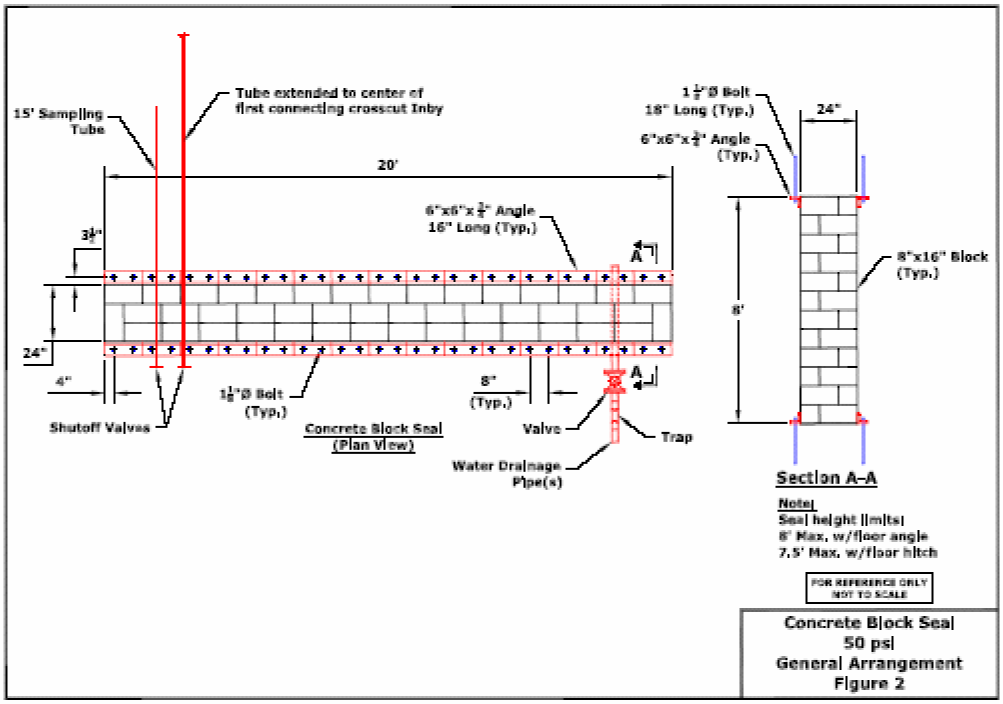


Figure 21. Comparing Model Predicted Displacement to Test Results. Model and test are expected to match closely until end of elastic response. Seal base released from floor at this time, and model to test comparisons are not meaningful beyond this point.

50 PSI CONCRETE BLOCK SEAL –
MSHA SEAL APPROVAL NUMBER 50-75.336.1.07.01.0



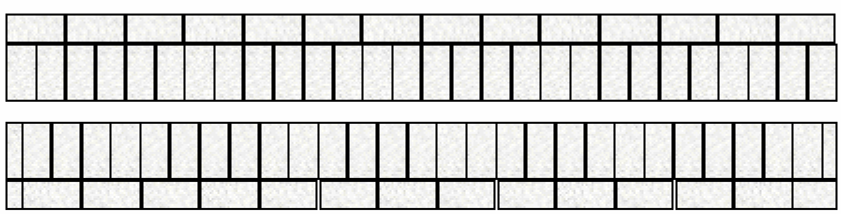


Figure 3 – Illustration of block pattern for alternate courses (in plan view) to stagger vertical joints.

Figure 22. Alternate Seal Design for Analysis, 50 psi Seal

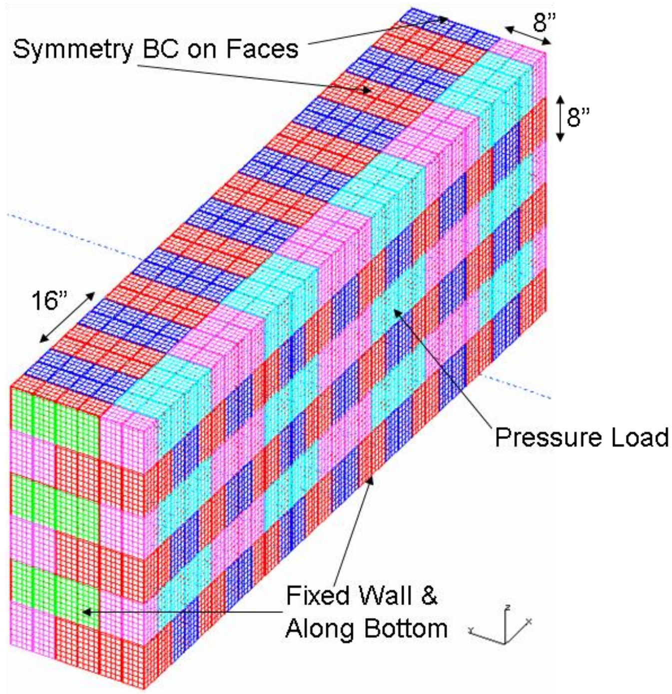


Figure 23. Finite Element Model of Alternate Seal, ¼ Symmetry Model. Each Block Individually Modeled in Prescribed Layup Orientation with Mortar Joints Explicitly Modeled Between Blocks.

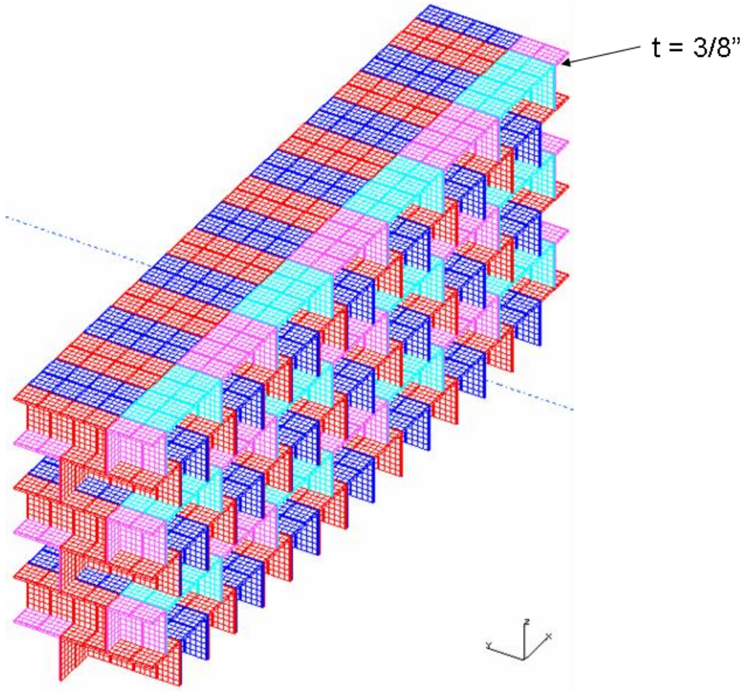


Figure 24. Finite Element Mesh of Alternate Seal Mortar Joints (1/4 symmetry)

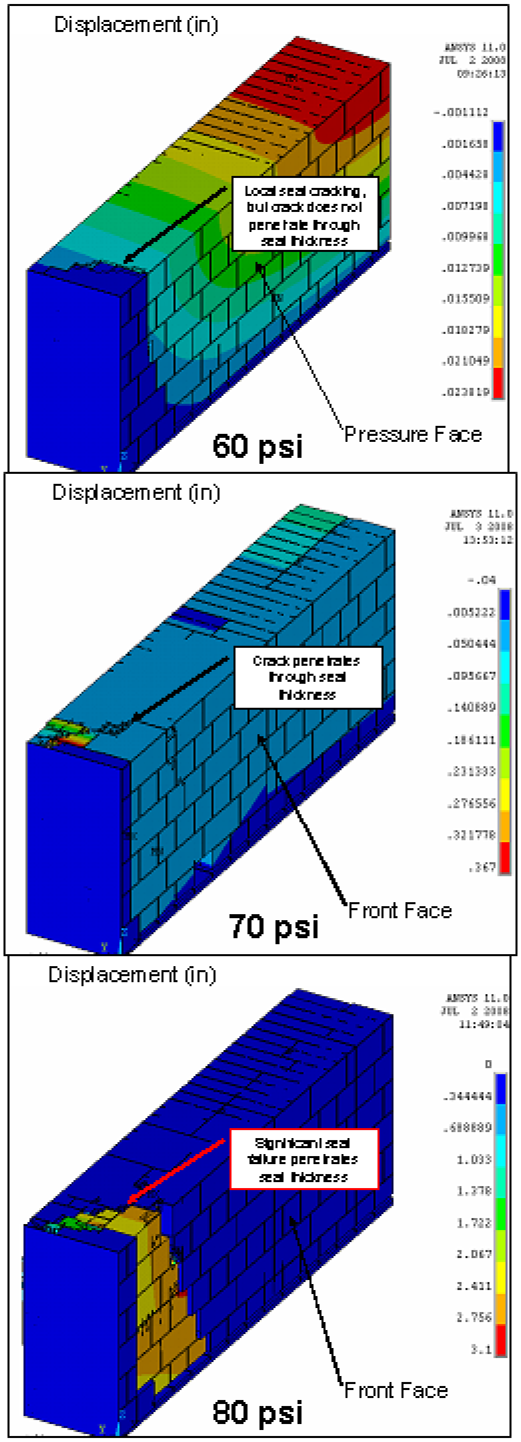


Figure 25. Failure Prediction of Uncoated Alternate Seal with Increasing Peak Blast Pressure. First through thickness crack shown at 70±10 psi blast peak pressure.

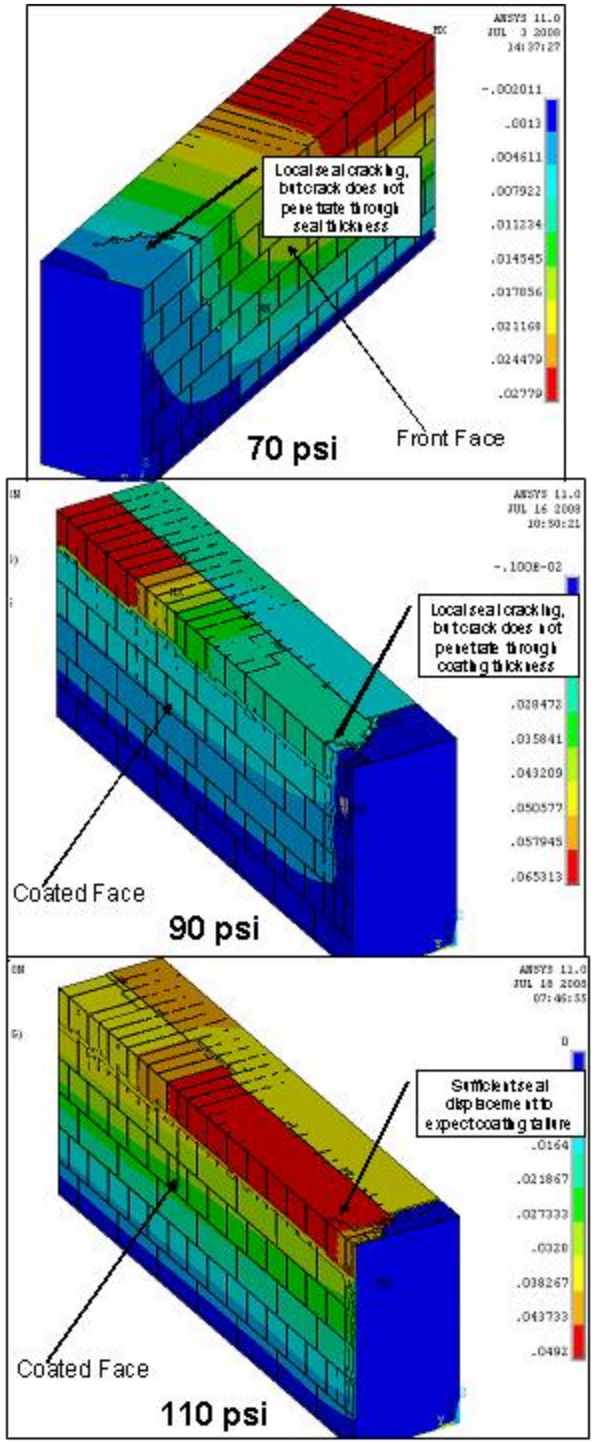


Figure 26. Failure Prediction of Coated Alternate Seal with Increasing Peak Blast Pressure. First through thickness crack shown at 90 psi blast peak pressure.

Appendix B

Polyurea Coating Properties
(Physical Properties, DMA, Flame Spread Test, and Toxic Gas Test)

BDL95617B/CAT137 - DURABED©
Two Component Polyurea White Coating

BDL95617B is a two-component, flexible white coating used for mine seal protection.
The polyurea chemistry provides a high level of toughness and flexibility at various temperatures.

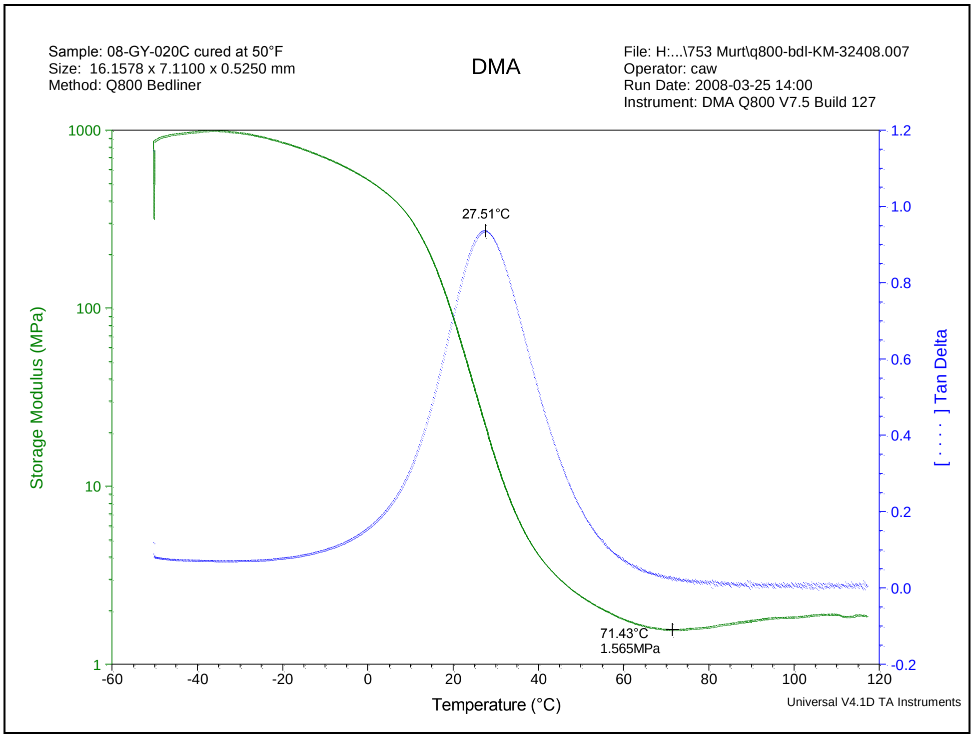
PROPERTIES	**BDL95617B (part B)**	**CAT137 (part A)**	**BDL95617B as Applied (part B + part A)**
Brookfield viscosity (cps) @ 23C	400 - 800	300 - 700	-
Weight/gallon (lbs)	8.69 - 8.89	9.32 - 9.52	-
Specific Gravity	1.055	1.13	1.093
Weight Solids (% theoretical)	100	99.98	100
Flash Point (Pensky-Martens Closed Cup)	*230°F	*201°F	-
Tensile Strength (MPa)	-	-	11 - 15
Elongation (%)	-	-	260 - 310
Young's Modulus (MPa)			11 - 15
Substrate type	-	-	Concrete block wall
Color	White	Clear	White
Storage Temperature (F)	50 - 100	50 - 100	-
Pumping Temperature (F)	50 - 100	50 - 100	-
Shelf life (unopened containers)	6 months	6 months	-

BDL95617B/CAT137 PAINT APPLICATION

Spray Temperature (F)	50 - 90°F
Spray gun type	Plas-Pak Dual Cartridge Gun
Orfice Restrictor	OR-1
Static Mixer	3/8X24 W/1/4X6
Gun pressure (psi)	30-40
BDL95617B/CAT133 mix ratio (volume)	1/1
Tack free time (seconds)	90 - 130
Recommended dry film thickness (mils)	125 - 150 mils
Safety Equipment for Manual Application	See MSDS

Notes: *Flash Points represent minimum values. Actual values to be confirmed.
**Humidity does not affect application characteristics, but a dry surface is required (no condensation).
***For some substrates and coatings systems, a narrower spray temperature range may be recommended.

Dynamic Mechanical Analysis (DMA) on Polyurea Coating



DMA Experimental Parameters

TA Instruments Q800 Unit
Mode: Tensile Film
Amplitude: 20 µm
Frequency: 1 Hz
Clamping Force: 18 cNm
Temperature Cycle: -50 to 120°C
Heating Rate: 3°C/min.
Sample Dimensions: ~15 x 6.5 x film thickness (mm)

ASTM E162 TESTING
FOR
PPG INDUSTRIES INC.
ON
BDL-95617B/CAT-137
VTEC #100-2937-1
TESTED: APRIL 25, 2008

VTEC Laboratories Inc.

April 25, 2008

Client: PPG Industries Inc.
4325 Rosanna Drive
Allison Park, PA 15101

Attention: Michael Rectenwald

I. SCOPE:

This report contains the reference to the test method, purpose, limitation, test procedure notes, preparation, and conditioning of specimens, calibration and reference samples, description of materials, operating data, and test results.

II. TEST METHOD:

The test was conducted in accordance with ASTM Designation E-162, "Standard Method of Test for Surface Flammability of Materials Using a Radiant Heat Energy Source".

III. PURPOSE:

The purpose of the test is to determine the relative surface flammability performance of various materials under specific test conditions when using a radiant heat source. The results are recorded as a Flamespread Index.

The surface flammability results of the radiant panel are sometimes used by building code authorities and the regulatory agencies for the acceptance of interior finish, kitchen cabinet materials, and products for various applications.

III. PURPOSE(con't)

The flamespread classification system used by most of the model building codes and the National Fire Protection Association Life Safety Code, NFPA No.101, encompasses the following:

Class A	(I)	0 to 25	Flamespread
Class B	(II)	26 to 75	Flamespread
Class C	(III)	76 to 100	Flamespread

IV. LIMITATIONS:

The Flamespread Classification system outlined above was based on the premise that the higher the flamespread numbers, the greater the fire hazard. The relationship between the numbers developed under ASTM E-162 and other surface flammability tests and life safety from fire has not been adequately established. The phenomenon of a destructive fire is very complicated and probably precludes the use of a single index to describe the level of fire hazard.

While existing flamespread test methods are useful tools, caution should be exercised in the use and interpretation of the numbers resulting; linearity should not be assumed: a material with a flamespread of 150 is not necessarily twice as hazardous as a material with a flamespread of 75.

V. TEST PROCEDURE NOTES:

A radiant panel 12″ wide by 18″ high of porous refractory material mounted vertically is preheated with a gas-air mixture to a radiant output equal to that obtained from a black body of the same dimensions operating at a temperature of 1238 +/- 7°F. (670 +/- 4°C).

A test specimen 6 inches wide by 18 inches high, suitably mounted in a frame is placed facing the radiant panel, but inclined at an angle of 30 degrees from top downward. A pilot burner adjusted to provide a 6" to 7" flame serves to ignite the sample at the top. The material under test burns downward. The operator records the flame

V. TEST PROCEDURE NOTES(con't)

progression time at 3, 6, 9, 12, and 15 inch interval marks measured from the top of the sample. The operator records the maximum temperature increase resulting from the burning sample measured by 8 thermocouples connected in parallel and located in the sheet metal stack above the tested sample. The Flamespread Index is derived by the following formula:

$$Is = Fs \times Q$$

where.... **Is** is the Flamespread Index
Fs is the Flamespread Factor
Q is the Heat Evolution Factor

The following provides a description of the two factors from which the Flamespread Index is calculated:

1) **Fs** - Flamespread Factor is determined by the speed at which the flame front burns down the specimen. The higher the value, generally the faster the specimen burns.

Specifically, the Fs is the sum of: one, plus the reciprocal of the times in minutes that the flame front burns from each of the three inch intervals down the specimen:

$$Fs = 1 + \frac{1}{t3} + \frac{1}{t6-t3} + \frac{1}{t9-t6} + \frac{1}{t12-t9} + \frac{1}{t15-t12}$$

Where **t3** equals the time at 3″, **t6** the time at 6″, and so on. Excluding the first term, **1**, when the value of any term exceeds the value of any of the preceding terms, a special calculation procedure is used as outlined in E-162.

2) **Q** - Heat Evolution Factor is determined by the maximum temperature developed in the stack above the burning sample as a result of the burning characteristics of the material under test. Generally, the higher the value, the larger and/or hotter the flame during burning.

$$Q = \frac{5.7 \times T}{B}$$

where.....
5.7 is an arbitrary constant used to keep the results of this test consistent with results obtained prior to the metrification of this test.

V. TEST PROCEDURE NOTES(con't)

T is the maximum stack temperature rise in Celsius over that obtained with an asbestos board specimen.

B is a constant for each test apparatus derived from relating stack thermocouple temperature rise in degrees C to heat input in kilowatts.

VI. PREPARATION AND CONDITIONING OF TEST SAMPLES:

The 6" by 18" specimens are predried for 24 hours at 140°F (60°C) and then conditioned to equilibrium at a controlled temperature of 73°F (23 +/- 3°C), and a relative humidity of 50 +/- 5 percent.

Occasionally for research and development informational purposes, fewer than four determinations are conducted on a given sample.

VII. CALIBRATION AND REFERENCE STANDARD:

The VTEC radiant panel has been calibrated using the procedures as outlined in ASTM E-162 and in the Appendix to the standard. In addition to the periodic recalibration, VTEC from time to time checks procedural details and testing techniques by the use of surface flammability standard reference material #1002 (1/4" hardboard) obtained from the National Bureau of Standards.

VIII. DISCLAIMER:

This is a factual report of the results obtained from the laboratory tests of sample products. The results may be applied only to the products tested and should not be construed as applicable to other similar products of the manufacturer. The report is not a recommendation or a disapprobation by VTEC Laboratories Inc. of the material tested. While this report may be used for obtaining product acceptance, it may not be used in advertising.

E162 FLAME SPREAD DATA

COMPANY:	PPG Industries	VTEC #	100-2937-1
PRODUCT:	BDL-95617B/CAT-137		
COLOR:	White	AL FOIL ?	YES
DIMENSIONS:	6" X 18"	EXP TIME:	15 MIN.
THICKNESS:	0.175"	DATE:	4/25/2008
SPECIAL PREPARATION:	None		
OBSERVATIONS:	No unusual observation.		

TIME TO...	3 INCHES min.	6 INCHES min.	9 INCHES min.	12 INCHES min.	15 INCHES min.
SPECIMEN#					
1	1.08	7.83	-	-	-
2	0.85	5.53	-	-	-
3	1.02	6.08	9.42	-	-
4	0.92	5.75	-	-	-

SPECIMEN#	Fs	Q	Sample Wt KG	Base Temp deg C	Max Temp deg C	Is INDEX
1	2.07	3.30	0.689	151.0	168.5	6.85
2	2.39	3.44	0.817	151.0	169.2	8.21
3	2.46	4.10	0.806	149.8	171.5	10.06
4	2.29	5.23	0.804	151.3	179.0	11.99
AVERAGE :	2.30	4.02	0.779	150.8	172.1	9.28

TEST RESULTS:

AVG. FLAMESPREAD FACTOR (FS) = 2.30
AVERAGE HEAT OF EVOLUTION (Q) = 4.02
AVERAGE FLAMESPREAD INDEX (Is) = 9.28
FLAMESPREAD INDEX RANGE (Is) = 6.85 TO 11.99

Neil Schultz
Executive Director

Amirudin Rahim
Technical Director

BSS 7239

TOXIC GAS TESTING

FOR

PPG INDUSTRIES INC.

ON BDL-95617B/CAT-137

VTEC #100-2937-2

TESTED: MAY 6, 2008

VTEC Laboratories Inc.

May 7, 2008

Client: PPG Industries Inc.
4325 Rosanna Drive
Allison Park, PA 15101

Attention: Michael F. Rectenwald

Subject: Measure amount of toxic gas generation per BSS 7239

Sample Description: BDL-95617B/CAT-137

DISCLAIMER:

This test result alone does not assess the fire hazard of the material, or a product made from this material, under actual fire conditions. Consequently, the results of this test alone are not to be quoted in support of claims with respect to the fire hazard of the material or product under actual fire conditions. The results when used alone are only to be used for research and development, quality control and material specifications.

212 Manida Street • Bronx, New York 10474 • (718) 542-8248 • Fax: (718) 542-8759 • www.vteclabs.com

SAMPLE DESCRIPTION: BDL-95617B/CAT-137

RESULTS:

The following gas analyses were made after 4 minutes of exposure to 2.5w/cm² and in the flaming mode. Colorimetric Gas Detector Tubes were used in the toxic gas analysis. The results are as follows:

	SPECIMEN #1	SPECIMEN #2		
WEIGHT (g)	65.8	66.2		
GAS	CORRECTED PPM	CORRECTED PPM	AVERAGE PPM	STD. DEVIATION PPM
CO	300	330	315.0	21.213
HCN	35	50	42.5	10.607
SO_2	18	18	18.0	0.000
HCL	72	45	58.5	19.092
HF	0	0	0.0	0.000
NO	90	130	110.0	28.284
NO_2	1.5	3	2.3	1.061

AMBIENT TEMPERATURE:	67.7 deg. F
RELATIVE HUMIDITY:	49%
BAROMETRIC PRESSURE:	30.01 Inches of Mercury

Neil Schultz
Executive Director

A. Rahim
Amirudin Rahim
Technical Director

APPENDIX C

MICON 550 Mine Seal Construction Description

by

C.A Hollerich & E.S. Weiss

The MICON 550 seal with was constructed in A-drift between crosscuts 3 and 4 within the Lake Lynn Experimental Mine. The seal was constructed by: George Watson, Ray Watson, and Josh Bagnell of Micon Mining and Steve Sawyer of Sawyer Engineering (a consultant with Micon Mining). Jim Addis, Don Sellers, Frank Karnack, and Cindy Hollerich of NIOSH assisted with material mobilization/demobilization and documentation (April 15 thru May 6, 2008).

- The Micon 550 seal was installed within A-drift of the Lake Lynn Experimental Mine (LLEM). The ribs and roof of the LLEM consists of limestone and the floor consists of 8-in thick reinforced concrete.
- Seal was constructed across A-drift at A-375 or approximately 16-ft 11-in inby crosscut 4.
- Average entry dimensions at the seal location – 19.6-ft wide x 7.3-ft high.
- Plug type seal - no hitching.
- The seal was 32-in thick with a 16-in thick polyurethane/aggregate core.
- To better simulate coal mine floor undulations, attempts were made to scrabble the reinforced concrete mine floor in A-drift using a CP drill with chipper bit.
- Wedges were used under the first block course to make level; later these wedges were removed after the Roklok-70 high-density polyurethane foam was applied. The Roklok-70 is a two-component material consisting of Roklok BE-1002 ISO (GMID # 157171; Lot # WC1101BS15) and Roklok (TM) BG-2000 Polyol (GMID# 157679; Batch # WA3001BS08).
- Construction of the back and front wall consisted of approximately 316, 8-in by 8-in by 16-in solid-concrete blocks and 33 cut blocks (each wall was 12 courses high with 14-16 blocks per course). The 8-in solid blocks weighed an average of 65.5 lb. Both walls were dry-stacked and separated by 16-in. Wood wedges were used at each rib to tighten blocks in each course. To fill the gap between the top block course and the mine roof, wood wedges and 13, 4-in by 8-in by 16-in half blocks (solid-concrete) were used.
- After the back wall was completed, six full courses of the dry-stacked outby (front) wall were installed followed by a pyramid-style installation for the middle block for the remaining courses to the mine roof (this resulted in two openings through the front wall to allow for the stowing of the aggregate and the injection of the polyurethane; the pyramid-style on the front wall provided support to the front wall while still permitting the installation of the core). A shop vacuum was used to remove dust from the strata and blocks within the core. The opening in

the front wall on each course was filled with block as the height of the core increased.

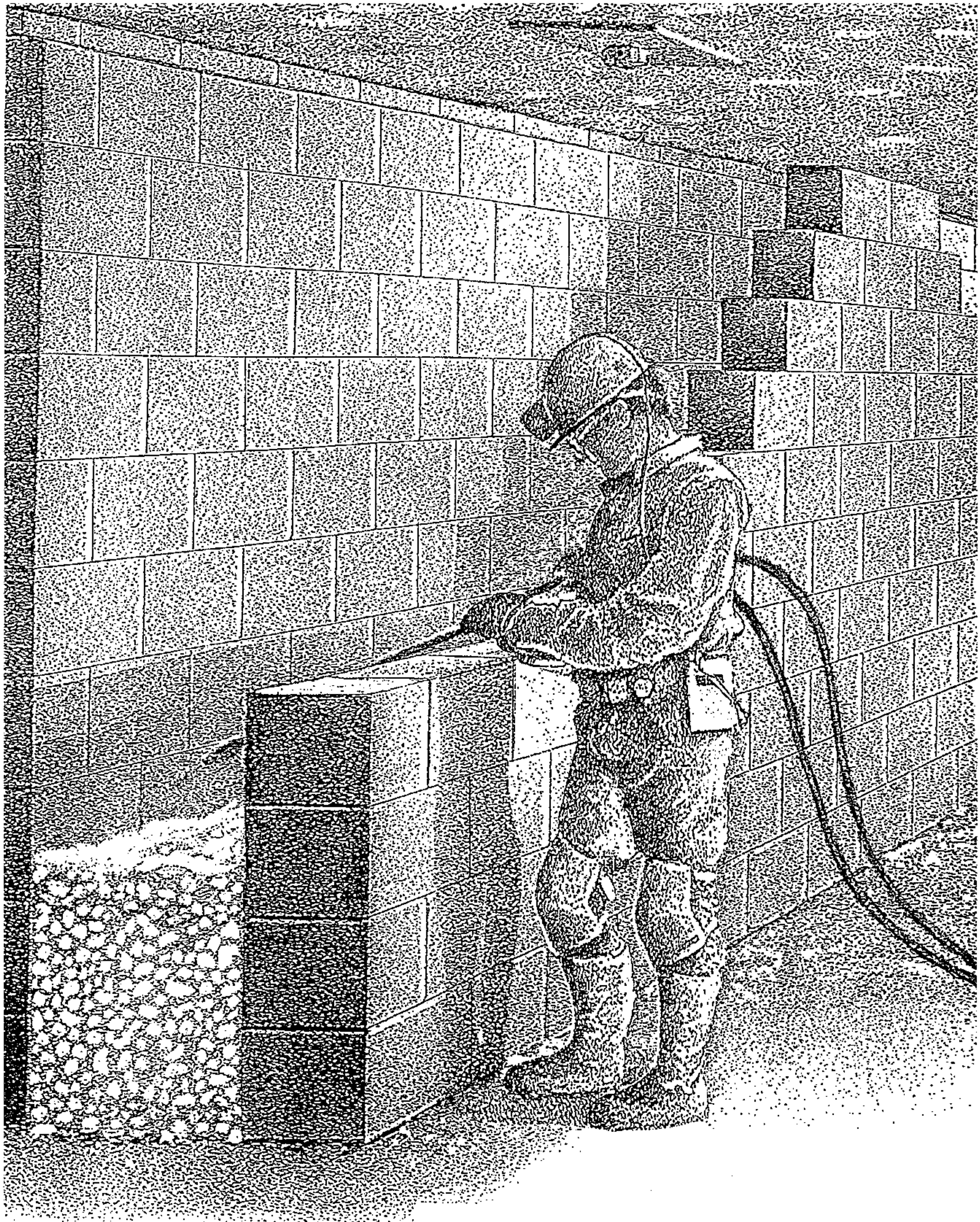
- A torpedo heater was used underground to ensure the temperature of the Roklok-70 was at least 55ºF (with the heater, the temperature of the Roklok-70 prior to application was 67-68ºF).
- Using a hydraulic twin set gear pump, Roklok-70 was injected between the two dry-stacked concrete block walls to cover the lower portion of the ribs, the first course of wall block, the floor, and under the first course of block as the gaps permitted. Handfuls of gravel where then spread on the floor, and Roklok-70 was then used to cover this very thin gravel layer (the gravel was to be spread on the concrete floor prior to the application of the Roklok-70). The wood wedges used under the first course of block for leveling purposes were removed after a short period of time (when the Roklok-70 hardened). Roklok-70 continued to be used to coat the ribs and wall blocks as the core height increased. A total of ~60 lb of Roklok-70 was used during the construction of the Micon 550 seal.
- Five (5) buckets of TNT Trowel Pro Seal Mine Sealant 3839 (Pyro-Chem Corporation, South Point, OH) was applied (¼-in thick coating) to the inby side of the inby (back) wall.
- For the first lift, seventeen (17) 50-lb buckets of washed and dried #57 river rock aggregate was spread on the first Roklok-70/aggregate thin lift on the floor. Using a hydraulic twin set gear pump, Seal Lok 120 was then pumped onto this aggregate lift.
- A total of six (6) polyurethane/aggregate lifts were required to fill the core. A total of 100 buckets (50 lb each) of washed and dried #57 river rock aggregate were used for this seal; seventeen (17) buckets per lift except for lifts 2 and 3 which used sixteen (16) buckets.
- Using a hydraulic twin set gear pump, approximately 1,815 lb of Seal Lok 120 (at a pumping rate of about 2.5 gals per minute) was required to complete the seal core. As with the Roklok-70, a heater was used to ensure the temperature of the Seal Lok 120 was adequate. Prior to pumping the Seal Lok 120, the material was heated to a temperature of 67-68ºF. Seal Lok 120 is a two-component material consisting of Roklok BE-1000 Isocyanate (GMID # 157169; Lot # WD0301BS09) and Roklok BG-2001 Polyol (GMID # 157680; Lot # WD0301BS10).
- The density of the polyurethane/aggregate core was calculated to be approximately 35.7 lb/ft^3 (based on a core volume of ~190.8 ft^3 and the weights of the materials used).
- Jam rods (total of 6) were used along the roof / block interface to inject additional Seal Lok 120 into the core under pressure to better ensure complete closure to the roof; this process was initiated after allowing the core a short set period.
- Sealant was not used on the outby side of the outby (front) wall since it would have been necessary to then remove the sealant prior to the installation of the PPG retrofit.
- The mine temperature ranged from 55-62ºF and relative humidity ranged from 38-

100% during the seal construction period.

- The construction of Micon 550 seal required approximately 129 worker-hr or 6-½ days to complete.

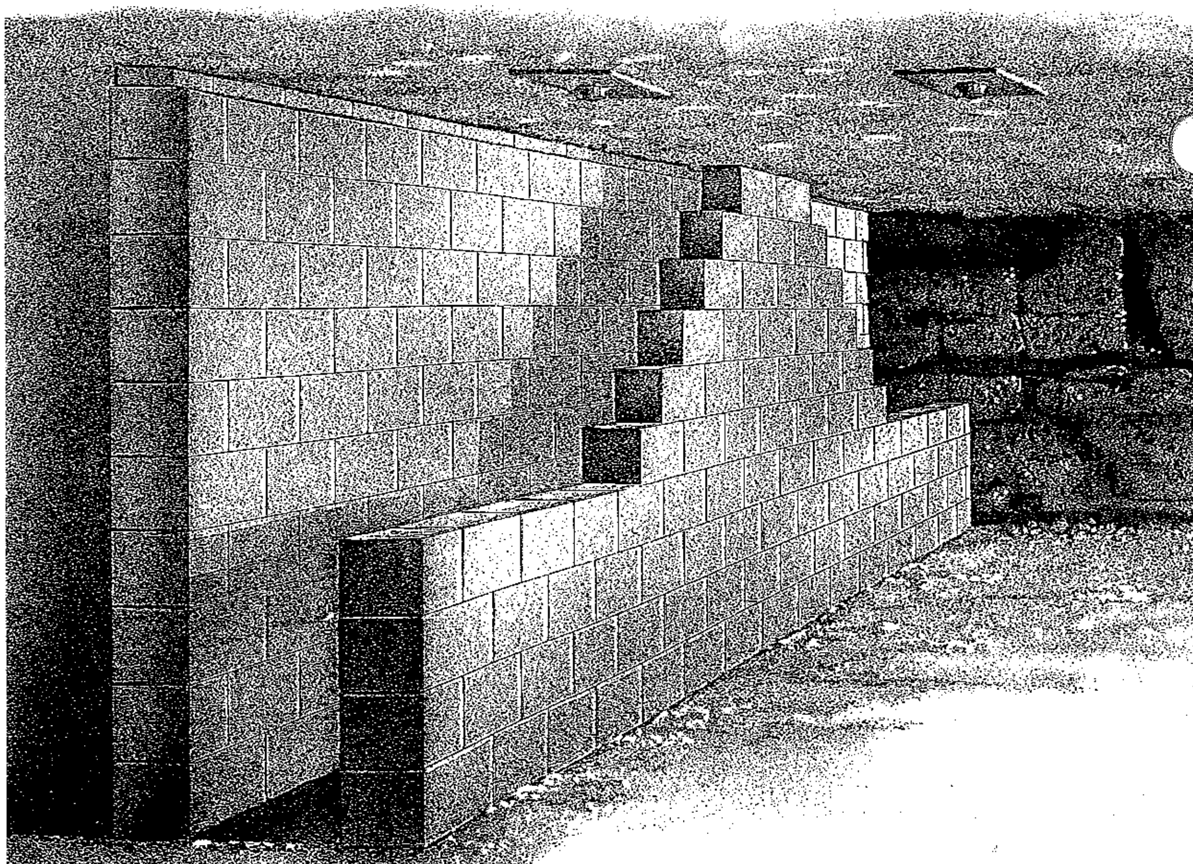
APPENDIX D

MICON 550 Technical Bulletin



MICON

Permanent Ventilation Seal Construction Technique



III. Block Wall Construction

MICON Permanent Ventilation Seal Construction Technique

The MICON Permanent Ventilation Seal consists of two surface bonded, drystacked concrete stopping walls and a special polymer and aggregate inner core.

I. Seal Placement

A. It is the responsibility of the mine to determine the location of the seal. Placement must be according to MSHA and the applicable state guidelines.

B. Ideally, the seal **must** be placed in an area with competent and uniform roof, rib and bottom conditions.

II. Site Preparation

A. **Hitching is not required** in the construction of the MICON Permanent Ventilation Seal.

B. Sound and scale down any loose material from roof and rib. Shovel and pick down bottom to a solid base where possible. The overall seal site width will range from approximately thirty inches (30") to thirty-six inches (36").

III. Block Wall Construction

A. **All walls are dry stacked.**

B. The block walls as constructed for the MICON Permanent Ventilation Seal are "dry" block stoppings.

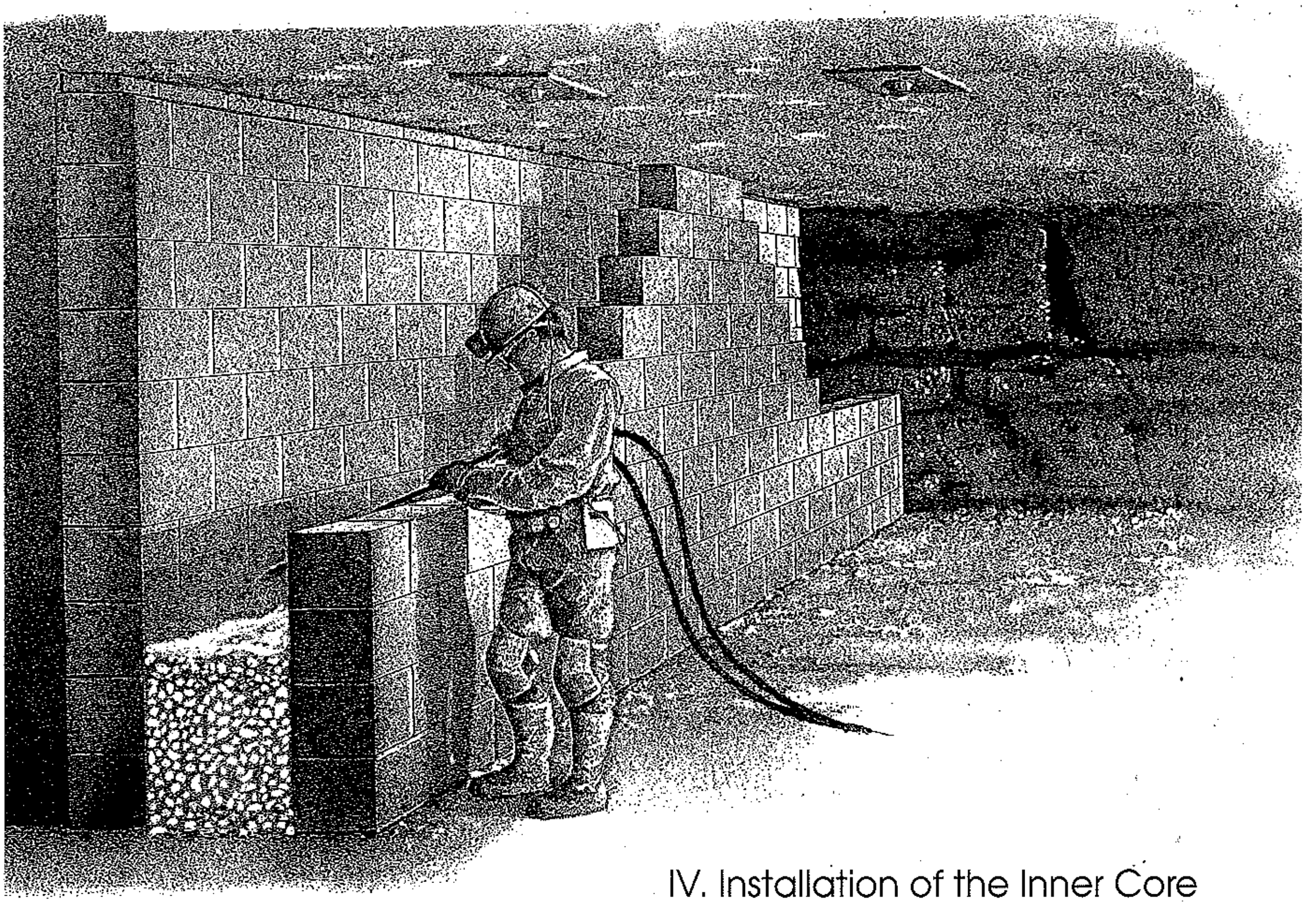
C. Materials required:

- Cement Block - 4", 6" or 8" width Entry dimension range (HxW) of 7'-8' x 16'-18' would require a minimum of 130-165 blocks (6"x8"x16")
- Wedges
- Planks--for use as scaffolding in high entries

D. Tools and equipment required:

- Mason's hammer
- String Level Pick and shovel

E. Erecting the Block Walls



IV. Installation of the Inner Core

The back wall is constructed first. Establish the first row on solid bottom, using a sight string or similar method to keep the construction level. Using a mason's hammer, tap the blocks together to close in the sides. Tap in each subsequent block as close to the other blocks as possible.

After the first row is constructed, the remaining rows are installed. All blocks are stacked in place without mortar.

After the last block of each row is in place, drive a wedge between the block and rib to firmly tighten the blocks in place. Fill all notches and holes with block fragments and wedge in place.

The backside of the back wall must be plastered with an MSHA approved sealant.

When constructing the last seal in a series, a manhole shall be left open to facilitate plastering the backside of the wall. After plastering the backside of the wall, the manhole shall be closed by individually hand plastering the blocks into place. The very last block will be wet laid using the sealant.

After completing the back wall, measure and mark the core thickness of the seal, then begin constructing the front wall. Establish the first row on solid bottom, using a sight string or similar method to keep the construction level. Square and tighten blocks together as they are stacked in place.

After the first row is laid, **the front wall is initially constructed to a height of two to three feet** (dependent on seal height). All blocks are stacked in place without mortar. After the last block of each row is in place, drive a wedge between the block and rib to firmly tighten the blocks in place. Fill all notches and holes with block fragments and wedge in place.

Construction of the front wall is continued by pyramiding the block to the roof so that one or two blocks are in contact with the roof. After the top blocks are in place, drive a wedge between the block and roof to hold the block in place.

Begin installation of the inner core. As the inner core is installed, construction of the front wall continues to completion.

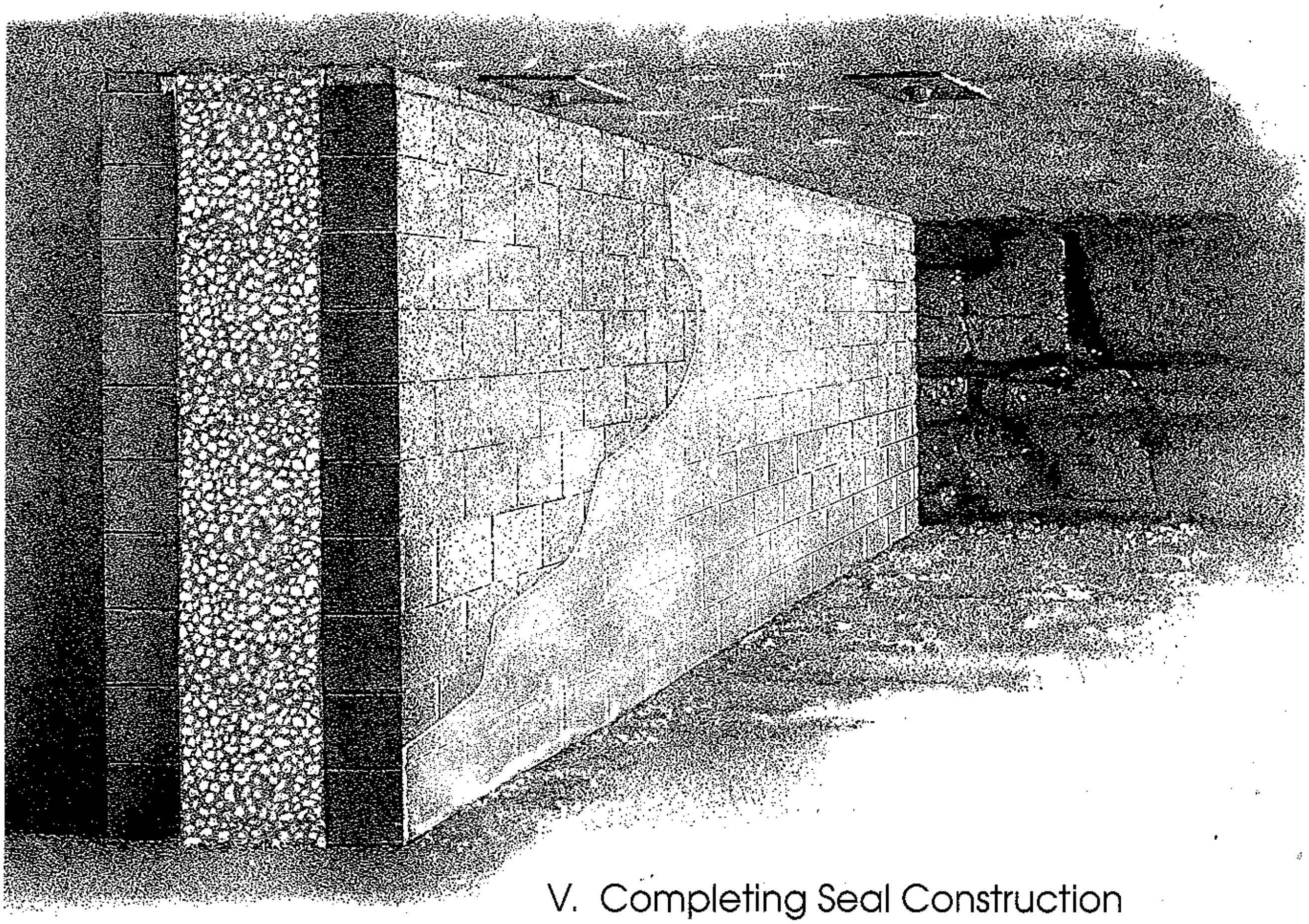
The front side of the front wall must be plastered with an MSHA approved sealant.

In mines experiencing roof convergence and/or floor heave, one row of cement block can be substituted with wood. The wood must be the same height and width of the cement block which it is replacing.

IV. Installation of the Inner Core

A. The inner core of the seal is defined as that part of the seal between the two block walls consisting of a polymer grout and aggregate. Its thickness is determined according to the overall height of the seal.

B. Use the following table to determine the thickness of the inner core:



V. Completing Seal Construction

Seal Height	Inner Core Thickness
Less than 8.00'	16"
8.01'-9.00'	17"
9.01'-10.00'	18"
10.01'-11.00'	19"
11.01'-12.00'	20"
12.01'-13.00'	21"
13.01'-14.00'	22"
14.01'-15.00'	23"

C. Materials required:
- MPG-550 Polymer binder. Two components (A and B) make up the MPG-550; each component is packaged in 55 gallon drums. The two components are pumped and mixed together at a 1:1 ratio.
- Aggregrate. The aggregate is packaged in fifty pound (50#) bags which are palletized and shrink wrapped.

D. Tools and equipment required:
- Two component polymer grout pump
- Power source for pump (air or hydraulic)

E. Inner Core Construction
The initial step in the construction of the inner core is to coat the floor, the interface between the block walls and floor, and the block walls and ribs within the core area with the polymer grout. Then, while the polymer is in its liquid state, apply a layer (approximately two to four inches in thickness) of aggregate onto the reacting polymer. Within several minutes, the polymer will react and rise within the aggregate.

After establishing the core base, installation proceeds as follows:

1. Place a layer of aggregate (four inches in depth) on the initial lift.
2. After placing aggregate, thoroughly coat it with polymer grout. The polymer will react and rise (along with the aggregate) to a height of approximately fourteen inches. Within five minutes, the core material is solidified and hardened.
3. **Repeat Steps 1 and 2 to roof to complete seal.**

V. Completing Seal Construction

A. After completing installation of the seal, inspect the seal for air leakage.

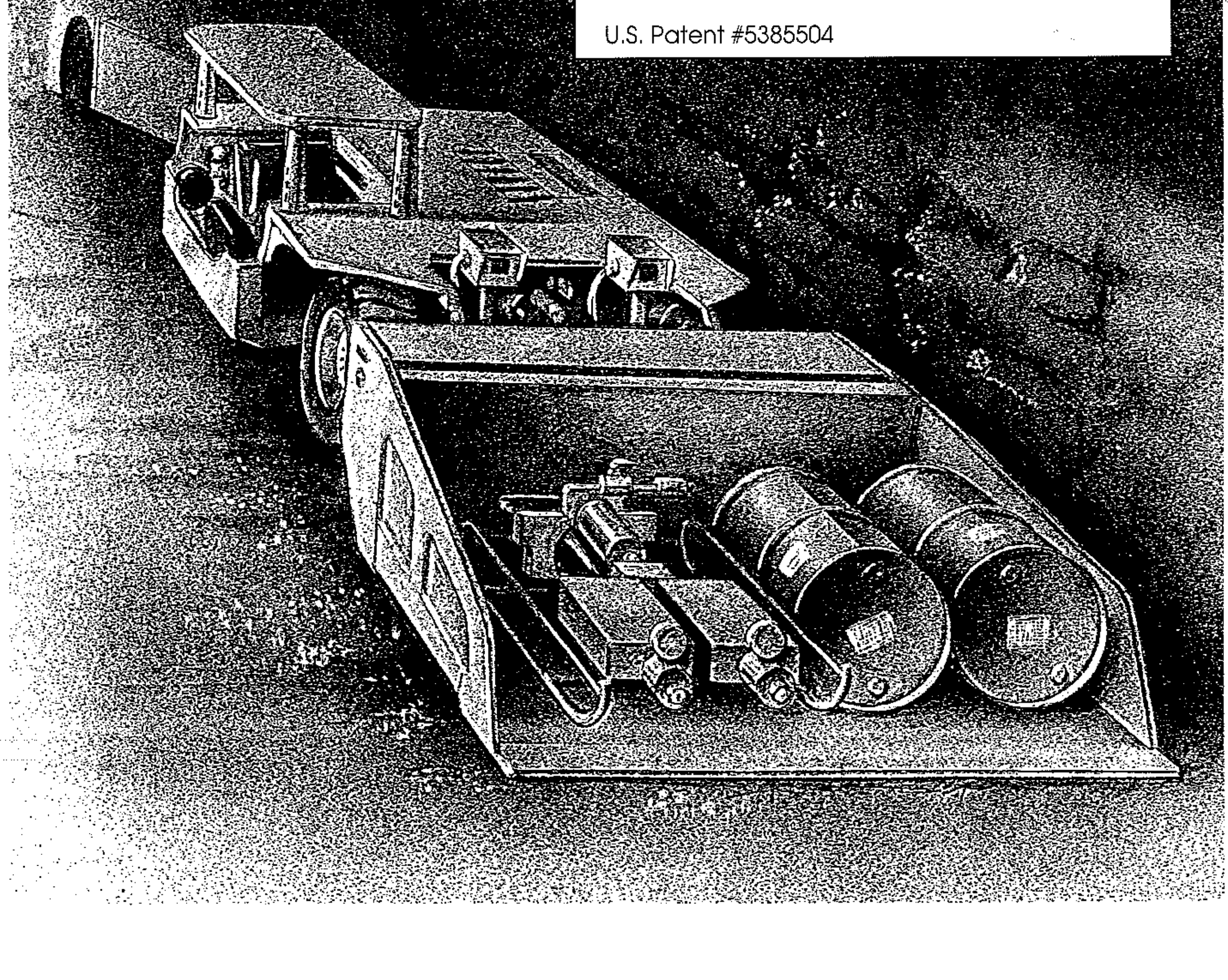
B. If there is any leakage, seal it by injecting MPG-550 polymer or **using MICON's Foam Pak,** a portable, reusable polyurethane foam system specifically designed for patching and sealing.

HERE'S THE SCOOP!!

NO COSTLY ELECTRIC AND WATER INSTALLATION

The patented MICON Permanent Ventilation Seal meets MSHA 30CFR 75.335 (a)(12) standards. Its uncomplicated design offers an economical breakthrough in seal construction procedures. Traditional ventilation seals use cement and block that deteriorate in a short time. The MICON Permanent Ventilation Seal is comprised of an inner core of MICON polymer and stone aggregate that forms a composite structure with the concrete block walls. State-of-the-art polymers are stable for decades and are not affected by air, acid and the hostile environment in which seals must be expected to perform. Solid cinder block walls give the MICON seal a five hour burn-through rating (ASTM E119), greatly exceeding MSHA one hour burn-through requirements. Cost saving construction procedures - inexpensive formwork, no water line, limited power hookups and low manpower requirement - have enabled MICON to design a permanent ventilation seal that will last.

U.S. Patent #5385504



MICON

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P.O. Box 59, Grand Junction, CO 81502-0059
(970) 858-0600 FAX: (970) 858-0696

Appendix E

Material Data Safety Sheet (MSDS) and Technical Data Sheets for Construction Materials

MATERIAL SAFETY DATA SHEET

1) PRODUCT AND COMPANY IDENTIFICATION

RokLok 70

THE DOW CHEMICAL COMPANY
Midland Michigan 48674
USA

24-Hour Emergency Phone Number: 989-636-4400
Customer Service: 800-366-4740

PRODUCT NAME : ROKLOK (TM) BE-1002 Isocyanate
MATERIAL TYPE : isocyanate
ISSUE DATE : 07/19/2007
REVISION DATE : 01/12/2007

2) COMPOSITION/INFORMATION ON INGREDIENTS

Ingredient	CAS Number	%
Polymethylene polyphenyl isocyanate (containing 4,4'methylene bisphenyl isocyanate CAS# 101-68-8 at approximately 40-50%)	9016-87-9	60-100%

3) HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

Sprayed or heated material harmful if inhaled. May cause allergic skin reaction. May cause allergic respiratory reaction and lung injury. Avoid temperatures above 105F (41C). Toxic flammable gases and heat are released under decomposition conditions. Toxic fumes may be released in fire situations. Reacts slowly with water, releasing carbon dioxide, which can cause pressure buildup and rupture of closed containers. Elevated temperatures accelerate this process.

EYE

May cause moderate eye irritation. May cause very slight transient (temporary) corneal injury.

SKIN

Prolonged or repeated exposure may cause slight skin irritation. May cause allergic skin reaction in susceptible individuals. Animal studies have shown that skin contact with isocyanates may play a role in respiratory sensitization. May stain skin. A single prolonged exposure is not likely to result in the material being absorbed in harmful amounts.

INGESTION

Single dose oral toxicity is considered to be low. No hazards anticipated from swallowing small amounts incidental to normal handling operations.

INHALATION

At room temperature, vapors are minimal due to low vapor pressure. However, certain operations may generate vapor or aerosol concentrations sufficient to cause irritation or other adverse effects. Such operations include those in which the material is heated, sprayed or otherwise mechanically dispersed such as drumming, venting or pumping. Excessive exposure may cause irritation to upper respiratory tract and lungs, and pulmonary edema (fluid in the lungs). May cause respiratory sensitization in susceptible individuals. MDI concentrations below the exposure guidelines may cause allergic respiratory reactions in individuals already sensitized. Symptoms may include coughing, difficult breathing and a feeling of tightness in the chest. Effects may be delayed. Decreased lung function has been associated with overexposure to isocyanates.

SYSTEMIC EFFECTS

Tissue injury in the upper respiratory tract and lungs has been observed in laboratory animals after repeated excessive exposures to MDI/polymeric MDI aerosols.

TERATOLOGY

In laboratory animals, MDI/polymeric MDI did not cause birth defects; other fetal effects occurred only at high doses which were toxic to the mother.

CANCER INFORMATION

Lung tumors have been observed in laboratory animals exposed to aerosol droplets of MDI/Polymeric MDI (6 mg/m3) for their lifetime. Tumors occurred concurrently with respiratory irritation and lung injury. Current exposure guidelines are expected to protect against these effects reported for MDI.

4) FIRST-AID MEASURES

EYE

Irrigate with flowing water immediately and continuously for 15 minutes. Remove contacts after first five minutes and continue washing. Consult medical personnel.

SKIN

Remove material from skin immediately by washing with soap and plenty of water. Remove contaminated clothing and shoes while washing. Seek medical attention if irritation persists. An MDI skin decontamination study demonstrated that a polyglycol-based skin cleanser or corn oil may be more effective than soap and water.

INGESTION

If swallowed, seek medical attention. Do not induce vomiting unless directed to do so by medical personnel.

INHALATION

Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, oxygen should be administered by qualified personnel. Call a physician or transport to a medical facility.

NOTE TO PHYSICIAN

No specific antidote. Provide supportive care. Treatment based on judgment of the physician in response to reactions of the patient. May cause respiratory sensitization or asthma-like symptoms. Bronchodilators, expectorants, and antitussives may be of help. Respiratory symptoms, including pulmonary edema, may be delayed. Persons receiving significant exposure should be observed for 24-48 hours for signs of respiratory distress.

5) FIRE-FIGHTING MEASURES

FLAMMABLE PROPERTIES

FLASH POINT: >400F, >204C

METHOD USED: PMCC, ASTM D93

AUTOIGNITION TEMPERATURE: >1100F, 600C

FLAMMABILITY LIMITS

LFL: Not applicable.

UFL: Not applicable.

HAZARDOUS COMBUSTION PRODUCTS

During a fire, smoke may contain the original material in addition to unidentified toxic and/or irritating compounds. Hazardous combustion products may include but are not limited to: nitrogen oxides, isocyanates, hydrogen cyanide, carbon monoxide, and carbon dioxide.

OTHER FLAMMABILITY INFORMATION

Product reacts with water. Reaction may produce heat and/or gases. Reaction may be violent. Container may rupture from gas generation in a fire situation. Violent steam generation or eruption may occur upon application of direct water stream to hot liquids. Dense smoke is produced when product burns. Spills of these organic liquids on hot fibrous insulations may lead to lowering of the atoignition temperatures possibly resulting in spontaneous combustion.

EXTINGUISHING MEDIA

Use carbon dioxide, dry chemical, foam, water fog or fine spray. Alcohol resistant foams (ATC type) are preferred if available. General purpose synthetic foams (including AFFF) or protein foams may function, but much less effective. Do not use direct water stream which can spread fire.

FIRE FIGHTING INSTRUCTIONS

Keep people away. Isolate fire area and deny unnecessary entry. Stay upwind. Keep out of low areas where gases (fumes) can accumulate. Water is not recommended but may be applied in very large quantities as a fine spray when other extinguishing agents are not available. Contain fire water run-off if possible. Do not use direct water stream. May spread fire. Fight fire from protected location or safe distance. Consider use of unmanned hose holder or monitor nozzles. Use water spray to cool fire exposed containers and fire affected zone until fire is out. Immediately withdraw all personnel from area in case of rising sound from venting safety devices or discoloration of the containers. Move containers from fire area if this is possible without hazard.

PROTECTIVE EQUIPMENT - FIRE FIGHTERS

Wear positive-pressure self-contained breathing apparatus (SCBA) and protective fire fighting clothing (includes fire fighting helmet, coat, pants, boots, and gloves). Avoid contact with this material during fire fighting operations. If contact is likely, change to full chemical resistant clothing with SCBA. If his will not provide sufficient fire protection; consider fighting fire from a remote location.

6) ACCIDENTAL RELEASE MEASURES

PROTECT PEOPLE

Avoid any contact. Barricade area. Clear non-emergency personnel from area. Keep upwind of spill. Ventilate area of leak or spill. The area must be evacuated and reentered by persons equipped for decontamination. Use appropriate safety equipment. If available, use foam to suppress vapors.

PROTECT THE ENVIRONMENT

Contain liquid to prevent contamination of soil, surface water or ground water. Keep out of ditches, sewers, and water supplies. Should the product enter sewers or drains, it should be pumped into a covered, vented container; the cover should be placed loosely on the container but not made pressure tight. Move to a well-ventilated area. Emergency services may need to be called to assist in the cleanup operation.

CLEAN-UP

Supplies of suitable decontaminant should always be kept available. Absorb with material such as: sawdust, vermiculite, dirt, sand, clay, cob grit, Milsorb. Avoid materials such as cement powder. Collect material in suitable and properly labeled OPEN containers. Do not place in sealed container. Prolonged contact with water results in a chemical reaction which may result in rupture of the container. Place in: polylined fiber pacs, plastic drums, or properly labeled metal containers. Remove to a well ventilated area. Clean up floor areas. Attempt to neutralize by suitable decontaminant solution: Formulation 1: sodium carbonate 5-10%; liquid detergent 0.2-2%; water to make up to 100%. OR Formulation 2: Concentrated ammonia solution 3-8%; liquid detergent 0.2-2%; water to make up to 100%. If ammonia is used, use good ventilation to prevent vapor exposure. If you have any questions on how to neutralize call The Dow Chemical Company.

7) HANDLING AND STORAGE

HANDLING

Avoid contact of this product with water at all times during handling and storage. Use only with adequate ventilation. Keep equipment clean. Use disposable containers and tools where possible. Do not eat, drink, or smoke in working area.

STORAGE

Store in a dry place between 75F-105F (24C-41C). Keep containers tightly closed when not in use. Protect from atmospheric moisture. Maintain a nitrogen atmosphere. Do not store product contaminated with water to prevent potentially hazardous reaction.

8) EXPOSURE CONTROL/PERSONAL PROTECTION

ENGINEERING CONTROLS

Use only with adequate ventilation. Provide general and/or local exhaust ventilation to control airborne levels below the exposure guidelines. Exhaust systems should be designed to move the air away from the source of vapor/aerosol generation and the people working at this point. Odor is inadequate warning of excessive exposure.

EYE/FACE PROTECTION

Use chemical goggles.

SKIN PROTECTION

Use protective clothing impervious to this material. Selection of specific items such as faceshield, gloves, boots, apron, or full-body suit will depend on operation. Consideration of all chemicals involved, time and the dexterity needed to safely complete the job must be considered. Solvents can significantly change the permeation of a chemical through a barrier. Work with your safety equipment supplier to obtain the best Personal Protective Equipment for the job. Nitrile gloves are often found to be appropriate for work with MDI. Butyl rubber, PVC and neoprene are also often chosen.

Remove contaminated clothing immediately, wash skin area with soap and water (warm water if available) and launder clothing before reuse. Items which cannot be decontaminated, such as shoes, belts and watchbands, should be removed and destroyed.

RESPIRATORY PROTECTION

Atmospheric levels should be maintained below the exposure guideline. When atmospheric levels may exceed the exposure guideline, use an approved air-purifying respirator equipped with an organic vapor sorbent and a particle filter. For situations where the atmospheric levels may exceed the level for which an air-purifying respirator is effective, use a positive-pressure air-supplying respirator (airline or self-contained breathing apparatus). For emergency response or for situations where the atmospheric level is unknown, use an approved positive-pressure self-contained breathing apparatus.

EXPOSURE GUIDELINES(S)

Methylene bisphenyl isocyanate (MDI): ACGIH TLV is 0.005 ppm TWA and OSHA PEL is 0.02 ppm Ceiling. PELs are in accord with those recommended by OSHA, as in the 1989 revision of PELs.

9) PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE/PHYSICAL STATE

Brown liquid.

ODOR

Slightly musty.

VAPOR PRESSURE

<1 x 10(-5) mm Hg @ 25C

VAPOR DENSITY

8.5 (air = 1)

BOILING POINT
410 F (210 C) @ 5 mm Hg

SOLUBILITY IN WATER
Insoluble in water; reacts with evolution of C02.

SPECIFIC GRAVITY
1.24 @ 20C

10) STABILITY AND REACTIVITY

CHEMICAL STABILITY
Stable under recommended storage conditions.

INCOMPATIBILITY WITH OTHER MATERIALS
Avoid contact with acids, water, alcohols, amines, ammonia, bases, moist air, and strong oxidizers. Avoid contact with metals such as aluminum, brass, copper, galvanized metals, tin, zinc. Avoid contact with moist organic absorbents. Reaction with water will generate carbon dioxide and heat. Generation of gas can cause pressure buildup in closed systems. Avoid unintended contact with polyols. The reaction of polyols and isocyanates generate heat. Diisocyanates react with many materials and the rate of reaction increases with temperature as well as increased contact; these reactions can become violent. Contact is increased by stirring or if the other material mixes with the diisocyanate. Diisocyanates are not soluble in water and are denser than water and sink to the bottom, but react slowly at the interface. The reaction forms carbon dioxide gas and a layer of solid polyurea.

HAZARDOUS DECOMPOSITION PRODUCTS
Hazardous decomposition products depend upon temperature, air supply and the presence of other materials. Gases are released during decomposition.

HAZARDOUS POLYMERIZATION
Can occur. Polymerization can be catalyzed by: strong bases and water. Can react with itself at temperatures above 320F (160C).

11) TOXICOLOGICAL INFORMATION

TOXICOLOGICAL INFORMATION
Assesments may be based on studies of the individual components or on families of chemicals.

SKIN
MDI: The LD50 for skin absorption in rabbits is > 2000 mg/kg.

INGESTION
MDI: The oral LD50 for rats is > 10,000 mg/kg.

MUTAGENICITY
MDI: Mutagenicity data on MDI are inconclusive. MDI was weakly positive in some in-vitro (test tube) studies;

other in-vitro studies were negative. A mutagenicity study in animals was negative.

12) ECOLOGICAL INFORMATION

MOVEMENT & PARTITIONING
Based on information for MDI and polymeric MDI. In the aquatic or terrestrial environment, movement is expected to be limited by its reactivity with water forming predominantly insoluble polyureas.

DEGRADATION & PERSISTENCE
Based on information for MDI and polymeric MDI. In the aquatic and terrestrial

environment, material reacts with water forming predominantly insoluble polyureas which appear to be stable. In the atmospheric environment, material is expected to have a short tropospheric half-life, based on calculations and by analogy with related diisocyanates.

ECOTOXICITY

Based on information for MDI and polymerc MDI. The measured ecotoxicity is that of the hydrolzed product, generally under conditions maximizing production of soluble species. Material is practically non-toxic to aquatic organisms on an acute basis (LC50/EC50 > 100 mg/L in most sensitive species). The LC50 in earthworm Eisenia foetida is > 1000 mg/kg.

13) DISPOSAL CONSIDERATIONS

DISPOSAL CONSIDERATIONS

FOR UNUSED & UNCONTAMINATED PRODUCT, the preferred options include sending to a licensed, permitted: recycler, reclaimer, incinerator or other thermal destruction device.

As a service to its customers, Dow can provide names of information resource to help identify waste management companies and other facilities which recycle, reprocess or manage chemicals or plastics, and that manage used drums. Telephone Dow's Customer Information Center at 800-258-2436 or 989-832-1556 for further details.

DISPOSAL

DO NOT DUMP INTO ANY SEWERS, ON THE GROUND, OR INTO ANY BODY OF WATER. All disposal methods must be in compliance with all Federal, State/Provincial and local laws and regulations. Regulations may vary in different locations. Waste characterizations and compliance with applicable laws are the responsibility solely of the waste generator. THE DOW CHEMICAL COMPANY HAS NO CONTROL OVER THE MANAGEMENT PRACTICES OR MANUFACTURING PROCESSES OF PARTIES HANDLING OR USING THIS MATERIAL. THE INFORMATION PRESENTED HERE PERTAINS ONLY TO THE PRODUCT AS SHIPPED IN ITS INTENDED CONDITION AS DESCRIBED IN MSDS SECTION 2 (Composition/Information On Ingredients).

14) TRANSPORT INFORMATION

US D.O.T.

This product is not regulated when packaged in containers holding less than 5000 lbs. of MDI. Otherwise, UN 3082 applies.

CANADIAN TDG

This product is not regulated when packaged in containers holding less than 5000 lbs of MDI.

15) REGULATORY INFORMATION

NOTICE

The information herein is presented in good faith and believed to be accurate as of the effective date shown above. However, no warranty, expressed or implied is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state or provincial, and local laws. The following specific information is made for the purpose of complying with numerous federal, state or provincial, and local laws and regulations. See other sections for health and safety information.

REGULATORY INFORMATION

U.S. REGULATIONS

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SARA 313 INFORMATION: This product contains the following subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372:

CHEMICAL NAME CAS NUMBER

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Methylene bis(phenylisocyanate) (MDI) 101-68-8

Polymeric Diphenylmethane diisocyanate (PMDI) 9016-87-9

SARA HAZARD CATEGORY: This product has been reviewed according to the EPA "Hazard Categories" promulgated under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) and is considered, under applicable definitions, to meet the following categories:

An immediate health hazard

A delayed health hazard

TOXIC SUBSTANCES CONTROL ACT (TSCA):

All ingredients are on the TSCA inventory or are not required to be listed on the TSCA inventory.

OSHA HAZARD COMMUNICATION STANDARD:

This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT (CERCLA,or SUPERFUND):

This product contains the following substance(s) listed as "Hazardous Substances" under CERCLA which may require reporting of releases:

Category:

Chemical Name CAS# RQ

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Methylene bisphenyl isocyanate 000101-68-8 5000 lbs

CALIFORNIA PROPOSITION 65: This product contains the following substances known to the state of California to cause cancer and/or reproductive harm.

NONE

PENNSYLVANIA STATE RIGHT TO KNOW: The following substances are listed on the PA Hazardous Substance or Environmentally Hazardous Substance List:

Methylene bisphenyl isocyanate 000101-68-8

CANADIAN REGULATIONS

WHMIS INFORMATION: The Canadian Workplace Hazardous Materials Information

System (WHMIS) Classification for this product is:

D2A - respiratory tract sensitizer

D2B - eye or skin irritant

D2B - skin sensitizer

Refer elsewhere in the MSDS for specific warnings and safe handling information. Refer to the employer's workplace education program.

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CPR STATEMENT: This product has been classified in accordance with the hazard criteria of the Canadian Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

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HAZARDOUS PRODUCTS ACT INFORMATION: This product contains the following ingredients which are Controlled Products and/or on the Ingredient Disclosure List (Canadian HPA section 13 and 14):

COMPONENTS:	CAS #
Methylene bis(phenylisocyanate) (MDI)	101-68-8

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA):

All substances in this product are listed on the Canadian Domestic Substances List (DSL) or are not required to be listed.

16) OTHER INFORMATION

OTHER INFORMATION

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) RATINGS:

Health 2

Flammability 1

Reactivity 1

OTHER INFORMATION: The reaction of polyols and isocyanates generate heat. Contact of the reacting materials with skin or eyes can cause severe burns and may be difficult to remove from the affected areas. In addition, such contact increases the risk of isocyanate vapors.

(TM),*, OR (R) INDICATES A TRADEMARK OF THE DOW CHEMICAL COMPANY

MATERIAL SAFETY DATA SHEET

RokLok 70B

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

24-Hour Emergency Phone Number: 989-636-4400

Product Name: **ROKLOK* BG 2000 POLYOL**

GMID: 157679 Collective ID: 145

The Dow Chemical Company, Midland, MI 48674
Customer Service: 800-366-4740

2. COMPOSITION/INFORMATION ON INGREDIENTS

CHEMICAL	CAS#	CONCENTRATION
Polyglycols	Mixture(2)	60-100%
Diethylene glycol	111-46-6	10-30%

3. HAZARDS IDENTIFICATION

POTENTIAL HEALTH EFFECTS (See Section 11 for toxicological data.)

EYE: May cause slight temporary eye irritation.

SKIN: Prolonged or repeated exposure not likely to cause significant skin irritation. May cause more severe response if skin is abraded (scratched or cut). A single prolonged exposure is not likely to result in the material being absorbed through skin in harmful amounts. Material may be handled at elevated temperatures; contact with heated material may cause thermal burns.

INGESTION: Single dose oral toxicity is considered to be low. Small amounts swallowed incidental to normal handling operations are not likely to cause injury; swallowing amounts larger than that may cause injury.

INHALATION: At room temperatures, vapors are minimal due to physical properties; a single exposure is not likely to be hazardous. If material is heated or mist is produced, concentrations may be attained that are sufficient to cause respiratory irritation.

SYSTEMIC (OTHER TARGET ORGAN) EFFECTS Based on available data, repeated exposures to diethylene glycol may target the kidneys and liver.

4. FIRST-AID MEASURES

EYE: Flush eyes with plenty of water.

SKIN: Wash off in flowing water or shower.

INGESTION: If swallowed, seek medical attention. Do not induce vomiting unless directed to do so by medical personnel.

INHALATION: Remove to fresh air if effects occur. Consult a physician.

NOTE TO PHYSICIAN: No specific antidote. Supportive care. Treatment based on judgment of the physician in response to reactions of the patient.

5. FIRE-FIGHTING MEASURES

RokLok 70B

Extinguishing Media
Water fog or fine spray. Carbon dioxide, dry chemical, foam. Alcohol resistant foams (ATC type) are preferred if available. General purpose synthetic foams (including AFFF) or protein foams may function, but much less effectively.

Hazardous Combustion Products
Incomplete combustion may lead to the build-up of toxic pyrolysis products. Complete combustion will result in: Carbon oxides, Nitrogen oxides, Water, Ammonia and trace amounts of Hydrogen Cyanide.

Protection of Firefighters
Wear positive-pressure self-contained breathing apparatus (SCBA) and protective fire fighting clothing (includes fire fighting helmet, coat, pants, boots, and gloves). If protective equipment is not available or not used, fight fire from a protected location or safe distance.

Specific Fire or Explosion Hazards

6. ACCIDENTAL RELEASE MEASURES

PERSONAL PRECAUTIONS: Isolate area. May be a slipping hazard. Wear adequate personal protective equipment, see Section 8, EXPOSURE CONTROLS/PERSONAL PROTECTION.

ENVIRONMENTAL PRECAUTIONS: Contain material to prevent contamination of ground and surface water. Spills should be collected to prevent contamination of waterways. Recover if possible, or dispose of according to applicable regulations, see Section 13, DISPOSAL CONSIDERATIONS.

METHODS OF CLEANING UP: Spills should be contained by, and covered with large quantities of sand, earth or any other readily available absorbent material which is then brushed in vigorously to assist absorption. The mixture can then be collected into drums and removed for disposal. Wash area from residues with soap and water and rinse down. Contaminated water should be retained, not being allowed to flow into ground or surface water.

7. HANDLING AND STORAGE

HANDLING: Since polyols are handled together with diisocyanates, proper distinction between these two kinds of products is essential in order to avoid undesired mixing resulting in uncontrolled polymerisation.

STORAGE: Keep container tightly closed; product is hygroscopic.

- Storage Temperature: 60-90F (15.6-32.2C)

8. EXPOSURE CONTROL/PERSONAL PROTECTION

ENGINEERING CONTROLS: Use only with adequate ventilation. Local exhaust ventilation may be necessary for some operations.

PERSONAL PROTECTIVE EQUIPMENT

RESPIRATORY PROTECTION: For most conditions, no respiratory protection is needed; however, if handling at elevated temperature without sufficient ventilation or in presence of aerosols, use an approved air-purifying respirator.

SKIN PROTECTION: Use gloves impervious to this material. Wear clean,

long-sleeved, body covering clothing. After work and before eating, drinking or smoking wash and clean yourself carefully with soap and water. Contaminated
clothing should be washed and/or dry-cleaned before re-use.

EYE/FACE PROTECTION: Use chemical goggles. If vapor exposure causes eye discomfort, use a full-face respirator. Eye wash fountain should be located in immediate work area.

EXPOSURE GUIDELINES:
Diethylene Glycol: Workplace Environmental Exposure Level Guide (WEEL) is 10

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	: Liquid
Specific gravity	: Not Determined
Water solubility	: Not Determined
Flash point	: >212 deg.F (100 deg.C)

10. STABILITY AND REACTIVITY

CHEMICAL STABILITY: Stable under recommended storage conditions.

CONDITIONS TO AVOID: Product can oxidize at elevated temperatures. Product can decompose at elevated temperatures.

INCOMPATIBILITY WITH OTHER MATERIALS: Avoid contact with oxidizing materials. Avoid unintended contact with isocyanates. The reaction of polyols and isocyanates generates heat. Avoid contact with strong acids.

HAZARDOUS DECOMPOSITION PRODUCTS: None under normal conditions of storage and use.

HAZARDOUS POLYMERIZATION: Will not occur by itself.

11. TOXICOLOGICAL INFORMATION

INGESTION: The oral LD50 for rats is >2000 mg/kg.

SKIN CONTACT: The LD50 for skin absorption in rabbits is >2000 mg/kg

12. ECOLOGICAL INFORMATION

ECOLOGICAL INFORMATION

MOVEMENT & PARTITIONING: Bioconcentration potential is low for diethylene glycol. No bioconcentration is expected for the remaining components because of the relatively high molecular weight (MW greater than 1000).

DEGRADATION & PERSISTENCE: The diethylene glycol is readily biodegradable. It passes OECD test(s) for ready biodegradability. Based largely or completely on information for similar material, the remaining components are inherently biodegradable.

ECOTOXICITY: Based largely or completely on information for similar material. Material is practically non-toxic to aquatic organisms on an acute basis.

13. DISPOSAL CONSIDERATIONS

DISPOSAL CONSIDERATIONS (See Section 15 for Regulatory Information)

DISPOSAL: DO NOT DUMP INTO ANY SEWERS, ON THE GROUND, OR INTO ANY BODY OF WATER. All disposal methods must be in compliance with all Federal, State/Provincial and local laws and regulations. Regulations may vary in different locations. Waste characterizations and compliance with applicable laws are the responsibility solely of the waste generator. THE DOW CHEMICAL COMPANY HAS NO CONTROL OVER THE MANAGEMENT PRACTICES OR MANUFACTURING PROCESSES OF PARTIES HANDLING OR USING THIS MATERIAL. THE INFORMATION PRESENTED HERE PERTAINS ONLY TO THE PRODUCT AS SHIPPED IN ITS INTENDED CONDITION AS DESCRIBED IN MSDS SECTION 2 (Composition/Information On Ingredients).

FOR UNUSED & UNCONTAMINATED PRODUCT, the preferred options include sending to a licensed, permitted: recycler, reclaimer, incinerator.

As a service to its customers, Dow can provide names of information resources to help identify waste management companies and other facilities which recycle, reprocess or manage chemicals or plastics, and that manage used drums. Telephone Dow's Customer Information Center at 800-258-2436 or 517-832-1556 for further details.

14. TRANSPORT INFORMATION

DEPARTMENT OF TRANSPORTATION (D.O.T.):
This product is not regulated by D.O.T. when shipped domestically by land.
CANADIAN TDG INFORMATION:
This product is not regulated by TDG when shipped domestically by land.

15. REGULATORY INFORMATION

NOTICE: The information herein is presented in good faith and believed to be accurate as of the effective date shown above. However, no warranty, expressed or implied is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state or provincial, and local laws. The following specific information is made for the purpose of complying with numerous federal, state or provincial, and local laws and regulations. See other sections for health and safety information.

POLYGLYCOLS

U.S. REGULATIONS
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SARA 313 INFORMATION: To the best of our knowledge, this product contains no chemical subject to SARA Title III Section 313 supplier notification requirements.

SARA HAZARD CATEGORY: This product has been reviewed according to the EPA "Hazard Categories" promulgated under Sections 311 and 312 of the Superfund

15. REGULATORY INFORMATION

Amendment and Reauthorization Act of 1986 (SARA Title III) and is considered, under applicable definitions, to meet the following categories:
DIETHYLENE GLYCOL
An immediate health hazard
A delayed health hazard

TOXIC SUBSTANCES CONTROL ACT (TSCA):
All ingredients are on the TSCA inventory or are not required to be listed on the TSCA inventory.

STATE RIGHT-TO-KNOW: The following product components are cited on certain state lists as mentioned. Non-listed components may be shown in the composition section of the MSDS.

CHEMICAL NAME	CAS NUMBER	LIST
DIETHYLENE GLYCOL	111-46-6	PA1

PA1=Pennsylvania Hazardous Substance

OSHA HAZARD COMMUNICATION STANDARD:
This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT (CERCLA, or SUPERFUND):
To the best of our knowledge, this product contains no chemical subject to reporting under CERCLA.

CANADIAN REGULATIONS
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WHMIS INFORMATION: The Canadian Workplace Hazardous Materials Information System (WHMIS) Classification for this product is:
This product is not a "Controlled Product" under WHMIS.

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA):
All substances in this product are listed on the Canadian Domestic

16. OTHER INFORMATION

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) RATINGS:
Health 1
Flammability 1
Reactivity 1

The reaction of polyols and isocyanates generate heat. Contact of the reacting materials with skin or eyes can cause severe burns and may be difficult to remove from the affected areas. Immediately wash affected areas with plenty of water and seek medical assistance.

No other information.

MATERIAL SAFETY DATA SHEET

1) PRODUCT AND COMPANY IDENTIFICATION

SeaLok-120

THE DOW CHEMICAL COMPANY
Midland Michigan 48674
USA

24-Hour Emergency Phone Number: 989-636-4400
Customer Service: 800-366-4740

PRODUCT NAME : ROKLOK (TM) BE-1000 Isocyanate
MATERIAL TYPE : isocyanate
ISSUE DATE : 07/19/2007
REVISION DATE : 01/12/2007

2) COMPOSITION/INFORMATION ON INGREDIENTS

Ingredient	CAS Number	%
Polymethylene polyphenyl isocyanate (containing 4,4'methylene bisphenyl isocyanate CAS# 101-68-8 at approximately 40-50%)	9016-87-9	60-100%

3) HAZARDS IDENTIFICATION

EMERGENCY OVERVIEW

Sprayed or heated material harmful if inhaled. May cause allergic skin reaction. May cause allergic respiratory reaction and lung injury. Avoid temperatures above 105F (41C). Toxic flammable gases and heat are released under decomposition conditions. Toxic fumes may be released in fire situations. Reacts slowly with water, releasing carbon dioxide, which can cause pressure buildup and rupture of closed containers. Elevated temperatures accelerate this process.

EYE

May cause moderate eye irritation. May cause very slight transient (temporary) corneal injury.

SKIN

Prolonged or repeated exposure may cause slight skin irritation. May cause allergic skin reaction in susceptible individuals. Animal studies have shown that skin contact with isocyanates may play a role in respiratory sensitization. May stain skin. A single prolonged exposure is not likely to result in the material being absorbed in harmful amounts.

INGESTION

Single dose oral toxicity is considered to be low. No hazards anticipated from swallowing small amounts incidental to normal handling operations.

INHALATION

At room temperature, vapors are minimal due to low vapor pressure. However, certain operations may generate vapor or aerosol concentrations sufficient to cause irritation or other adverse effects. Such operations include those in which the material is heated, sprayed or otherwise mechanically dispersed such as drumming, venting or pumping. Excessive exposure may cause irritation to upper respiratory tract and lungs, and pulmonary edema (fluid in the lungs). May cause respiratory sensitization in susceptible individuals. MDI concentrations below the exposure guidelines may cause allergic respiratory reactions in individuals already sensitized. Symptoms may include coughing, difficult breathing and a feeling of tightness in the chest. Effects may be delayed. Decreased lung function has been associated with overexposure to isocyanates.

SYSTEMIC EFFECTS

Tissue injury in the upper respiratory tract and lungs has been observed in laboratory animals after repeated excessive exposures to MDI/polymeric MDI aerosols.

TERATOLOGY

In laboratory animals, MDI/polymeric MDI did not cause birth defects; other fetal effects occurred only at high doses which were toxic to the mother.

CANCER INFORMATION

Lung tumors have been observed in laboratory animals exposed to aerosol droplets of MDI/Polymeric MDI (6 mg/m3) for their lifetime. Tumors occurred concurrently with respiratory irritation and lung injury. Current exposure guidelines are expected to protect against these effects reported for MDI.

4) FIRST-AID MEASURES

EYE

Irrigate with flowing water immediately and continuously for 15 minutes. Remove contacts after first five minutes and continue washing. Consult medical personnel.

SKIN

Remove material from skin immediately by washing with soap and plenty of water. Remove contaminated clothing and shoes while washing. Seek medical attention if irritation persists. An MDI skin decontamination study demonstrated that a polyglycol-based skin cleanser or corn oil may be more effective than soap and water.

INGESTION

If swallowed, seek medical attention. Do not induce vomiting unless directed to do so by medical personnel.

INHALATION

Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, oxygen should be administered by qualified personnel. Call a physician or transport to a medical facility.

NOTE TO PHYSICIAN

No specific antidote. Provide supportive care. Treatment based on judgment of the physician in response to reactions of the patient. May cause respiratory sensitization or asthma-like symptoms. Bronchodilators, expectorants, and antitussives may be of help. Respiratory symptoms, including pulmonary edema, may be delayed. Persons receiving significant exposure should be observed for 24-48 hours for signs of respiratory distress.

5) FIRE-FIGHTING MEASURES

FLAMMABLE PROPERTIES

FLASH POINT: >400F, >204C

METHOD USED: PMCC, ASTM D93

AUTOIGNITION TEMPERATURE: >1100F, 600C

FLAMMABILITY LIMITS

LFL: Not applicable.

UFL: Not applicable.

HAZARDOUS COMBUSTION PRODUCTS

During a fire, smoke may contain the original material in addition to unidentified toxic and/or irritating compounds. Hazardous combustion products may include but are not limited to: nitrogen oxides, isocyanates, hydrogen cyanide, carbon monoxide, and carbon dioxide.

OTHER FLAMMABILITY INFORMATION

Product reacts with water. Reaction may produce heat and/or gases. Reaction may be violent. Container may rupture from gas generation in a fire situation. Violent steam generation or eruption may occur upon application of direct water stream to hot liquids. Dense smoke is produced when product burns. Spills of these organic liquids on hot fibrous insulations may lead to lowering of the atoignition temperatures possibly resulting in spontaneous combustion.

EXTINGUISHING MEDIA

Use carbon dioxide, dry chemical, foam, water fog or fine spray. Alcohol resistant foams (ATC type) are preferred if available. General purpose synthetic foams (including AFFF) or protein foams may function, but much less effective. Do not use direct water stream which can spread fire.

FIRE FIGHTING INSTRUCTIONS

Keep people away. Isolate fire area and deny unnecessary entry. Stay upwind. Keep out of low areas where gases (fumes) can accumulate. Water is not recommended but may be applied in very large quantities as a fine spray when other extinguishing agents are not available. Contain fire water run-off if possible. Do not use direct water stream. May spread fire. Fight fire from protected location or safe distance. Consider use of unmanned hose holder or monitor nozzles. Use water spray to cool fire exposed containers and fire affected zone until fire is out. Immediately withdraw all personnel from area in case of rising sound from venting safety devices or discoloration of the containers. Move containers from fire area if this is possible without hazard.

PROTECTIVE EQUIPMENT - FIRE FIGHTERS

Wear positive-pressure self-contained breathing apparatus (SCBA) and protective fire fighting clothing (includes fire fighting helmet, coat, pants, boots, and gloves). Avoid contact with this material during fire fighting operations. If contact is likely, change to full chemical resistant clothing with SCBA. If his will not provide sufficient fire protection; consider fighting fire from a remote location.

6) ACCIDENTAL RELEASE MEASURES

PROTECT PEOPLE

Avoid any contact. Barricade area. Clear non-emergency personnel from area. Keep upwind of spill. Ventilate area of leak or spill. The area must be evacuated and reentered by persons equipped for decontamination. Use appropriate safety equipment. If available, use foam to suppress vapors.

PROTECT THE ENVIRONMENT

Contain liquid to prevent contamination of soil, surface water or ground water. Keep out of ditches, sewers, and water supplies. Should the product enter sewers or drains, it should be pumped into a covered, vented container; the cover should be placed loosely on the container but not made pressure tight. Move to a well-ventilated area. Emergency services may need to be called to assist in the cleanup operation.

CLEAN-UP

Supplies of suitable decontaminant should always be kept available. Absorb with material such as: sawdust, vermiculite, dirt, sand, clay, cob grit, Milsorb. Avoid materials such as cement powder. Collect material in suitable and properly labeled OPEN containers. Do not place in sealed container. Prolonged contact with water results in a chemical reaction which may result in rupture of the container. Place in: polylined fiber pacs, plastic drums, or properly labeled metal containers. Remove to a well ventilated area. Clean up floor areas. Attempt to neutralize by suitable decontaminant solution: Formulation 1: sodium carbonate 5-10%; liquid detergent 0.2-2%; water to make up to 100%. OR Formulation 2: Concentrated ammonia solution 3-8%; liquid detergent 0.2-2%; water to make up to 100%. If ammonia is used, use good ventilation to prevent vapor exposure. If you have any questions on how to neutralize call The Dow Chemical Company.

7) HANDLING AND STORAGE

HANDLING
Avoid contact of this product with water at all times during handling and storage. Use only with adequate ventilation. Keep equipment clean. Use disposable containers and tools where possible. Do not eat, drink, or smoke in working area.

STORAGE
Store in a dry place between 75F-105F (24C-41C). Keep containers tightly closed when not in use. Protect from atmospheric moisture. Maintain a nitrogen atmosphere. Do not store product contaminated with water to prevent potentially hazardous reaction.

8) EXPOSURE CONTROL/PERSONAL PROTECTION

ENGINEERING CONTROLS
Use only with adequate ventilation. Provide general and/or local exhaust ventilation to control airborne levels below the exposure guidelines. Exhaust systems should be designed to move the air away from the source of vapor/aerosol generation and the people working at this point. Odor is inadequate warning of excessive exposure.

EYE/FACE PROTECTION
Use chemical goggles.

SKIN PROTECTION
Use protective clothing impervious to this material. Selection of specific items such as faceshield, gloves, boots, apron, or full-body suit will depend on operation. Consideration of all chemicals involved, time and the dexterity needed to safely complete the job must be considered. Solvents can significantly change the permeation of a chemical through a barrier. Work with your safety equipment supplier to obtain the best Personal Protective Equipment for the job. Nitrile gloves are often found to be appropriate for work with MDI. Butyl rubber, PVC and neoprene are also often chosen.

Remove contaminated clothing immediately, wash skin area with soap and water (warm water if available) and launder clothing before reuse. Items which cannot be decontaminated, such as shoes, belts and watchbands, should be removed and destroyed.

RESPIRATORY PROTECTION
Atmospheric levels should be maintained below the exposure guideline. When atmospheric levels may exceed the exposure guideline, use an approved air-purifying respirator equipped with an organic vapor sorbent and a particle filter. For situations where the atmospheric levels may exceed the level for which an air-purifying respirator is effective, use a positive-pressure air-supplying respirator (airline or self-contained breathing apparatus). For emergency response or for situations where the atmospheric level is unknown, use an approved positive-pressure self-contained breathing apparatus.

EXPOSURE GUIDELINES(S)
Methylene bisphenyl isocyanate (MDI): ACGIH TLV is 0.005 ppm TWA and OSHA PEL is 0.02 ppm Ceiling. PELs are in accord with those recommended by OSHA, as in the 1989 revision of PELs.

9) PHYSICAL AND CHEMICAL PROPERTIES

APPEARANCE/PHYSICAL STATE
Brown liquid.

ODOR
Slightly musty.

VAPOR PRESSURE
<1 x 10(-5) mm Hg @ 25C

VAPOR DENSITY

8.5 (air = 1)

BOILING POINT
410 F (210 C) @ 5 mm Hg

SOLUBILITY IN WATER
Insoluble in water; reacts with evolution of C02.

SPECIFIC GRAVITY
1.24 @ 20C

10) STABILITY AND REACTIVITY

CHEMICAL STABILITY
Stable under recommended storage conditions.

INCOMPATIBILITY WITH OTHER MATERIALS
Avoid contact with acids, water, alcohols, amines, ammonia, bases, moist air, and strong oxidizers. Avoid contact with metals such as aluminum, brass, copper, galvanized metals, tin, zinc. Avoid contact with moist organic absorbents. Reaction with water will generate carbon dioxide and heat. Generation of gas can cause pressure buildup in closed systems. Avoid unintended contact with polyols. The reaction of polyols and isocyanates generate heat. Diisocyanates react with many materials and the rate of reaction increases with temperature as well as increased contact; these reactions can become violent. Contact is increased by stirring or if the other material mixes with the diisocyanate. Diisocyanates are not soluble in water and are denser than water and sink to the bottom, but react slowly at the interface. The reaction forms carbon dioxide gas and a layer of solid polyurea.

HAZARDOUS DECOMPOSITION PRODUCTS
Hazardous decomposition products depend upon temperature, air supply and the presence of other materials. Gases are released during decomposition.

HAZARDOUS POLYMERIZATION
Can occur. Polymerization can be catalyzed by: strong bases and water. Can react with itself at temperatures above 320F (160C).

11) TOXICOLOGICAL INFORMATION

TOXICOLOGICAL INFORMATION
Assesments may be based on studies of the individual components or on families of chemicals.

SKIN
MDI: The LD50 for skin absorption in rabbits is > 2000 mg/kg.

INGESTION
MDI: The oral LD50 for rats is > 10,000 mg/kg.

MUTAGENICITY
MDI: Mutagenicity data on MDI are inconclusive. MDI was weakly positive in some in-vitro (test tube) studies;

other in-vitro studies were negative. A mutagenicity study in animals was negative.

12) ECOLOGICAL INFORMATION

MOVEMENT & PARTITIONING
Based on information for MDI and polymeric MDI. In the aquatic or terrestrial environment, movement is expected to be limited by its reactivity with water forming predominantly insoluble polyureas.

DEGRADATION & PERSISTENCE
Based on information for MDI and polymeric MDI. In the aquatic and terrestrial

environment, material reacts with water forming predominantly insoluble polyureas which appear to be stable. In the atmospheric environment, material is expected to have a short tropospheric half-life, based on calculations and by analogy with related diisocyanates.

ECOTOXICITY

Based on information for MDI and polymerc MDI. The measured ecotoxicity is that of the hydrolzed product, generally under conditions maximizing production of soluble species. Material is practically non-toxic to aquatic organisms on an acute basis (LC50/EC50 > 100 mg/L in most sensitive species). The LC50 in earthworm Eisenia foetida is > 1000 mg/kg.

13) DISPOSAL CONSIDERATIONS

DISPOSAL CONSIDERATIONS

FOR UNUSED & UNCONTAMINATED PRODUCT, the preferred options include sending to a licensed, permitted: recycler, reclaimer, incinerator or other thermal destruction device.

As a service to its customers, Dow can provide names of information resource to help identify waste management companies and other facilities which recycle, reprocess or manage chemicals or plastics, and that manage used drums. Telephone Dow's Customer Information Center at 800-258-2436 or 989-832-1556 for further details.

DISPOSAL

DO NOT DUMP INTO ANY SEWERS, ON THE GROUND, OR INTO ANY BODY OF WATER. All disposal methods must be in compliance with all Federal, State/Provincial and local laws and regulations. Regulations may vary in different locations. Waste characterizations and compliance with applicable laws are the responsibility solely of the waste generator. THE DOW CHEMICAL COMPANY HAS NO CONTROL OVER THE MANAGEMENT PRACTICES OR MANUFACTURING PROCESSES OF PARTIES HANDLING OR USING THIS MATERIAL. THE INFORMATION PRESENTED HERE PERTAINS ONLY TO THE PRODUCT AS SHIPPED IN ITS INTENDED CONDITION AS DESCRIBED IN MSDS SECTION 2 (Composition/Information On Ingredients).

14) TRANSPORT INFORMATION

US D.O.T.

This product is not regulated when packaged in containers holding less than 5000 lbs. of MDI. Otherwise, UN 3082 applies.

CANADIAN TDG

This product is not regulated when packaged in containers holding less than 5000 lbs of MDI.

15) REGULATORY INFORMATION

NOTICE

The information herein is presented in good faith and believed to be accurate as of the effective date shown above. However, no warranty, expressed or implied is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state or provincial, and local laws. The following specific information is made for the purpose of complying with numerous federal, state or provincial, and local laws and regulations. See other sections for health and safety information.

REGULATORY INFORMATION

U.S. REGULATIONS

SARA 313 INFORMATION: This product contains the following subject to the reporting requirements of Section 313 of Title III of the Superfund Amendments and Reauthorization Act of 1986 and 40 CFR Part 372:

CHEMICAL NAME	CAS NUMBER
Methylene bis(phenylisocyanate) (MDI)	101-68-8
Polymeric Diphenylmethane diisocyanate (PMDI)	9016-87-9

SARA HAZARD CATEGORY: This product has been reviewed according to the EPA "Hazard Categories" promulgated under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) and is considered, under applicable definitions, to meet the following categories:

An immediate health hazard

A delayed health hazard

TOXIC SUBSTANCES CONTROL ACT (TSCA):

All ingredients are on the TSCA inventory or are not required to be listed on the TSCA inventory.

OSHA HAZARD COMMUNICATION STANDARD:

This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT (CERCLA,or SUPERFUND):

This product contains the following substance(s) listed as "Hazardous Substances" under CERCLA which may require reporting of releases:

Category:

Chemical Name	CAS#	RQ
Methylene bisphenyl isocyanate	000101-68-8	5000 lbs

CALIFORNIA PROPOSITION 65: This product contains the following substances known to the state of California to cause cancer and/or reproductive harm.

NONE

PENNSYLVANIA STATE RIGHT TO KNOW: The following substances are listed on the PA Hazardous Substance or Environmentally Hazardous Substance List:

Methylene bisphenyl isocyanate 000101-68-8

CANADIAN REGULATIONS

WHMIS INFORMATION: The Canadian Workplace Hazardous Materials Information System (WHMIS) Classification for this product is:

D2A - respiratory tract sensitizer

D2B - eye or skin irritant

D2B - skin sensitizer

Refer elsewhere in the MSDS for specific warnings and safe handling information. Refer to the employer's workplace education program.

- - - - -

CPR STATEMENT: This product has been classified in accordance with the hazard criteria of the Canadian Controlled Products Regulations (CPR) and the MSDS contains all the information required by the CPR.

- - - - -

HAZARDOUS PRODUCTS ACT INFORMATION: This product contains the following ingredients which are Controlled Products and/or on the Ingredient Disclosure List (Canadian HPA section 13 and 14):

COMPONENTS: CAS #

Methylene bis(phenylisocyanate) (MDI) 101-68-8

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA):

All substances in this product are listed on the Canadian Domestic Substances List (DSL) or are not required to be listed.

16) OTHER INFORMATION

OTHER INFORMATION

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) RATINGS:

Health 2

Flammability 1

Reactivity 1

OTHER INFORMATION: The reaction of polyols and isocyanates generate heat. Contact of the reacting materials with skin or eyes can cause severe burns and may be difficult to remove from the affected areas. In addition, such contact increases the risk of isocyanate vapors.

(TM),*, OR (R) INDICATES A TRADEMARK OF THE DOW CHEMICAL COMPANY

MATERIAL SAFETY DATA SHEET

MPG 550B

1. IDENTIFICATION OF THE SUBSTANCE/PREPARATION AND OF THE COMPANY/UNDERTAKING

24-Hour Emergency Phone Number: 989-636-4400

Product Name: **ROKLOK (TM) BG-2001 POLYOL**

GMID: 157680 Collective ID: 78

Material Type: Poly-Material

The Dow Chemical Company, Midland, MI 48674
Customer Service: 800-366-4740

2. COMPOSITION/INFORMATION ON INGREDIENTS

CHEMICAL	CAS#	CONCENTRATION
Polyols	Mixture	60-100%
Diethylene glycol	111-46-6	1-5;5-10

3. HAZARDS IDENTIFICATION

POTENTIAL HEALTH EFFECTS (See Section 11 for toxicological data.)

EYE: May cause slight temporary eye irritation.

SKIN: Prolonged or repeated exposure not likely to cause significant skin irritation. May cause more severe response if skin is abraded (scratched or cut). A single prolonged exposure is not likely to result in the material being absorbed through skin in harmful amounts. Material may be handled at elevated temperatures; contact with heated material may cause thermal burns.

INGESTION: Single dose oral toxicity is considered to be low. Small amounts swallowed incidental to normal handling operations are not likely to cause injury; swallowing amounts larger than that may cause injury.

INHALATION: At room temperatures, vapors are minimal due to physical properties; a single exposure is not likely to be hazardous. If material is heated or mist is produced, concentrations may be attained that are sufficient to cause respiratory irritation.

SYSTEMIC (OTHER TARGET ORGAN) EFFECTS Based on available data, repeated exposures to diethylene glycol may target the kidneys and liver.

4. FIRST-AID MEASURES

EYE: Flush eyes with plenty of water.

SKIN: Wash off in flowing water or shower.

INGESTION: If swallowed, seek medical attention. Do not induce vomiting unless directed to do so by medical personnel.

INHALATION: Remove to fresh air if effects occur. Consult a physician.

NOTE TO PHYSICIAN: No specific antidote. Supportive care. Treatment based on judgment of the physician in response to reactions of the patient.

5. FIRE-FIGHTING MEASURES

Extinguishing Media
Water fog or fine spray. Carbon dioxide, dry chemical, foam. Alcohol resistant foams (ATC type) are preferred if available. General purpose synthetic foams (including AFFF) or protein foams may function, but much less effectively.

Hazardous Combustion Products
Incomplete combustion may lead to the build-up of toxic pyrolysis products. Complete combustion will result in: Carbon oxides, Nitrogen oxides, Water, Ammonia and trace amounts of Hydrogen Cyanide.

Protection of Firefighters
Wear positive-pressure self-contained breathing apparatus (SCBA) and protective fire fighting clothing (includes fire fighting helmet, coat, pants, boots, and gloves). If protective equipment is not available or not used, fight fire from a protected location or safe distance.

Specific Fire or Explosion Hazards
Will support combustion.

6. ACCIDENTAL RELEASE MEASURES

PERSONAL PRECAUTIONS: Isolate area. May be a slipping hazard. Wear adequate personal protective equipment, see Section 8, EXPOSURE CONTROLS/PERSONAL PROTECTION.

ENVIRONMENTAL PRECAUTIONS: Contain material to prevent contamination of ground and surface water. Spills should be collected to prevent contamination of waterways. Recover if possible, or dispose of according to applicable regulations, see Section 13, DISPOSAL CONSIDERATIONS.

METHODS OF CLEANING UP: Spills should be contained by, and covered with large quantities of sand, earth or any other readily available absorbent material which is then brushed in vigorously to assist absorption. The mixture can then be collected into drums and removed for disposal. Wash area from residues with soap and water and rinse down. Contaminated water should be retained, not being allowed to flow into ground or surface water.

7. HANDLING AND STORAGE

HANDLING: Since polyols are handled together with diisocyanates, proper distinction between these two kinds of products is essential in order to avoid undesired mixing resulting in uncontrolled polymerisation.

STORAGE: Keep container tightly closed; product is hygroscopic.

- Storage Temperature: 60-90F (15.6-32.2C)

8. EXPOSURE CONTROL/PERSONAL PROTECTION

ENGINEERING CONTROLS: Use only with adequate ventilation. Local exhaust ventilation may be necessary for some operations.

PERSONAL PROTECTIVE EQUIPMENT

RESPIRATORY PROTECTION: For most conditions, no respiratory protection is needed; however, if handling at elevated temperature without sufficient ventilation or in presence of aerosols, use an approved air-purifying respirator.

SKIN PROTECTION: Use gloves impervious to this material. Wear clean, long-sleeved, body covering clothing. After work and before eating, drinking or smoking wash and clean yourself carefully with soap and water. Contaminated
clothing should be washed and/or dry-cleaned before re-use.

EYE/FACE PROTECTION: Use chemical goggles. If vapor exposure causes eye discomfort, use a full-face respirator. Eye wash fountain should be located in immediate work area.

EXPOSURE GUIDELINES:
Diethylene Glycol: Workplace Environmental Exposure Level Guide (WEEL) is 10

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance	: Liquid
Specific gravity	: Not Determined
Water solubility	: Not Determined
Flash point	: >212 deg.F (100 deg.C)

10. STABILITY AND REACTIVITY

CHEMICAL STABILITY: Stable under recommended storage conditions.

CONDITIONS TO AVOID: Product can oxidize at elevated temperatures. Product can decompose at elevated temperatures.

INCOMPATIBILITY WITH OTHER MATERIALS: Avoid contact with oxidizing materials. Avoid unintended contact with isocyanates. The reaction of polyols and isocyanates generates heat. Avoid contact with strong acids.

HAZARDOUS DECOMPOSITION PRODUCTS: None under normal conditions of storage and use.

HAZARDOUS POLYMERIZATION: Will not occur by itself.

11. TOXICOLOGICAL INFORMATION

INGESTION: The oral LD50 for rats is >2000 mg/kg.

SKIN CONTACT: The LD50 for skin absorption in rabbits is >2000 mg/kg

12. ECOLOGICAL INFORMATION

ECOLOGICAL INFORMATION

MOVEMENT & PARTITIONING: Bioconcentration potential is low for diethylene glycol. No bioconcentration is expected for the remaining components because of the relatively high molecular weight (MW greater
than 1000).

DEGRADATION & PERSISTENCE: The diethylene glycol is readily biodegradable. It passes OECD test(s) for ready biodegradability. Based largely or completely on information for similar material, the remaining components are inherently biodegradable.

ECOTOXICITY: Based largely or completely on information for similar material. Material is practically non-toxic to aquatic organisms on an acute basis.

13. DISPOSAL CONSIDERATIONS

DISPOSAL CONSIDERATIONS (See Section 15 for Regulatory Information)

DISPOSAL: DO NOT DUMP INTO ANY SEWERS, ON THE GROUND, OR INTO ANY BODY OF WATER. All disposal methods must be in compliance with all Federal, State/Provincial and local laws and regulations. Regulations may vary in different locations. Waste characterizations and compliance with applicable laws are the responsibility solely of the waste generator. THE DOW CHEMICAL COMPANY HAS NO CONTROL OVER THE MANAGEMENT PRACTICES OR MANUFACTURING PROCESSES OF PARTIES HANDLING OR USING THIS MATERIAL. THE INFORMATION PRESENTED HERE PERTAINS ONLY TO THE PRODUCT AS SHIPPED IN ITS INTENDED CONDITION AS DESCRIBED IN MSDS SECTION 2 (Composition/Information On Ingredients).

FOR UNUSED & UNCONTAMINATED PRODUCT, the preferred options include sending to a licensed, permitted: recycler, reclaimer, incinerator.

As a service to its customers, Dow can provide names of information resources to help identify waste management companies and other facilities which recycle, reprocess or manage chemicals or plastics, and that manage used drums. Telephone Dow's Customer Information Center at 800-258-2436 or 517-832-1556 for further details.

14. TRANSPORT INFORMATION

DEPARTMENT OF TRANSPORTATION (D.O.T.):
This product is not regulated by D.O.T. when shipped domestically by land.
CANADIAN TDG INFORMATION:
This product is not regulated by TDG when shipped domestically by land.

15. REGULATORY INFORMATION

NOTICE: The information herein is presented in good faith and believed to be accurate as of the effective date shown above. However, no warranty, expressed or implied is given. Regulatory requirements are subject to change and may differ from one location to another; it is the buyer's responsibility to ensure that its activities comply with federal, state or provincial, and local laws. The following specific information is made for the purpose of complying with numerous federal, state or provincial, and local laws and regulations. See other sections for health and safety information.

POLYGLYCOLS

U.S. REGULATIONS
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SARA 313 INFORMATION: To the best of our knowledge, this product contains no chemical subject to SARA Title III Section 313 supplier notification requirements.
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15. REGULATORY INFORMATION

SARA HAZARD CATEGORY: This product has been reviewed according to the EPA "Hazard Categories" promulgated under Sections 311 and 312 of the Superfund Amendment and Reauthorization Act of 1986 (SARA Title III) and is considered, under applicable definitions, to meet the following categories:
DIETHYLENE GLYCOL
An immediate health hazard
A delayed health hazard

TOXIC SUBSTANCES CONTROL ACT (TSCA):
All ingredients are on the TSCA inventory or are not required to be listed on the TSCA inventory.

STATE RIGHT-TO-KNOW: The following product components are cited on certain state lists as mentioned. Non-listed components may be shown in the composition section of the MSDS.

CHEMICAL NAME	CAS NUMBER	LIST
DIETHYLENE GLYCOL	111-46-6	PA1

PA1=Pennsylvania Hazardous Substance

OSHA HAZARD COMMUNICATION STANDARD:
This product is a "Hazardous Chemical" as defined by the OSHA Hazard Communication Standard, 29 CFR 1910.1200.

COMPREHENSIVE ENVIRONMENTAL RESPONSE COMPENSATION AND LIABILITY ACT (CERCLA, or SUPERFUND):
To the best of our knowledge, this product contains no chemical subject to reporting under CERCLA.

CANADIAN REGULATIONS

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WHMIS INFORMATION: The Canadian Workplace Hazardous Materials Information System (WHMIS) Classification for this product is:
This product is not a "Controlled Product" under WHMIS.

CANADIAN ENVIRONMENTAL PROTECTION ACT (CEPA):
All substances in this product are listed on the Canadian Domestic

16. OTHER INFORMATION

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) RATINGS:
Health 1
Flammability 1
Reactivity 1

The reaction of polyols and isocyanates generate heat. Contact of the reacting materials with skin or eyes can cause severe burns and may be difficult to remove from the affected areas. Immediately wash affected areas with plenty of water and seek medical assistance.

No other information.

MATERIAL SAFETY DATA SHEET

SECTION 1 - PRODUCT AND COMPANY INFORMATION

PPG Industries, Inc.
One PPG Place
Pittsburgh, PA 15272

EMERGENCY PHONE NUMBERS (24 hours/day): **(412) 434-4515 (U.S.)**
(514) 645-1320 (Canada)
01-800-00-21-400 (Mexico)
0532-83889090 (China)

TECHNICAL INFORMATION: (414) 764-6000 (OAK CREEK, WI) 8:00 a.m. - 5:00 p.m. Central
PRODUCT SAFETY/MSDS INFORMATION: (412) 492-5555 7:00 a.m. - 4:30 p.m. EST
Product ID: BDL95617B (0819-F1)
PRODUCT NAME: MINE SEAL WALL-UP
SYNONYMS: None
ISSUE DATE: 04/16/2008
EDITION NO.: 1
CHEMICAL FAMILY: AMINE/ESTER

EMERGENCY OVERVIEW:
CAUSES IRREVERSIBLE EYE DAMAGE. MAY BE CORROSIVE. THIS PRODUCT CONTAINS A MATERIAL WHICH CAUSES SKIN BURNS. PROLONGED OR REPEATED CONTACT MAY CAUSE AN ALLERGIC SKIN REACTION. MAY BE HARMFUL IF ABSORBED THROUGH THE SKIN.VAPOR IRRITATES EYES, NOSE, AND THROAT. VAPOR GENERATED AT ELEVATED TEMPERATURES IRRITATES EYES, NOSE AND THROAT. VAPOR AND/OR SPRAY MIST MAY BE HARMFUL IF INHALED.HARMFUL IF SWALLOWED.UNSTABLE - HAZARDOUS REACTIONS POSSIBLE. This product is not expected to present any unusual hazards under fire or spill conditions. Read entire MSDS before use.

SECTION 2 - COMPOSITION INFORMATION

The following ingredient(s) marked with an "x" are considered hazardous under applicable U.S. OSHA and/or Canadian WHMIS regulations. If no ingredients are listed, then there are no U.S. OSHA and/or Canadian WHMIS hazardous ingredients in this product.

Material/ CAS Number	Percent	Hazardous
POLYOXY PROPYLENE DIAMINE 9046-10-0	15 - 40	X
ASPARTIC ESTER Proprietary	10 - 30	X
ALICYCLIC AMINE 156105-38-3	10 - 30	X
SILICA 7631-86-9	3 - 7	X
TITANIUM DIOXIDE 13463-67-7	1 - 5	X

SECTION 3 - HAZARDS IDENTIFICATION

ACUTE OVEREXPOSURE EFFECTS

EYE CONTACT:
This product contains a material which causes irreversible eye damage. Redness, itching, burning sensation and visual disturbances may indicate excessive eye contact.

SKIN CONTACT:
May be corrosive. This product contains a material which causes skin burns. Dryness, itching, cracking, burning, redness, and swelling are conditions associated with excessive skin contact.

SKIN ABSORPTION:
Prolonged or repeated contact may cause an allergic skin reaction. May be harmful if absorbed through the skin.

INHALATION:
Vapor irritates eyes, nose, and throat. Vapor generated at elevated temperatures irritates eyes, nose and throat. Vapor and/or spray mist may be harmful if inhaled.

INGESTION:
Harmful if swallowed.

SIGNS & SYMPTOMS OF OVEREXPOSURE:
Repeated exposure to high vapor concentrations may cause irritation of the respiratory system and permanent brain and nervous system damage. Eye watering, headaches, nausea, dizziness and loss of coordination are indications that solvent levels are too high. Intentional misuse by deliberately concentrating and inhaling the contents can be harmful or fatal. Dryness, itching, cracking, burning, redness, and swelling are conditions associated with excessive skin contact.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Not applicable.

CHRONIC OVEREXPOSURE EFFECTS
Avoid long-term and repeated contact.
Repeated exposure to vapors above recommended exposure limits (see Section 8) may cause irritation of the respiratory system and permanent brain and nervous system damage. Intentional misuse by deliberately concentrating and inhaling the contents can be harmful or fatal.
The effects of long-term, low level exposures to this product have not been determined. Safe handling of this material on a long-term basis should emphasize the prevention of all contact with this material to avoid any effects from repetitive acute exposures. See Section 11, of this MSDS for a detailed list of chronic health effects information available on individual ingredients in this product.

SECTION 4 - FIRST AID MEASURES

If ingestion, irritation, any type of overexposure or symptoms of overexposure occur during or persists after use of this product, contact a POISON CONTROL CENTER, EMERGENCY ROOM OR PHYSICIAN immediately; have Material Safety Data Sheet information available.

EYE CONTACT:
Remove contact lens and pour a gentle stream of warm water through the affected eye for at least 15 minutes. Contact a poison control center, emergency room or physician right away as further treatment will be necessary.

SKIN CONTACT:
Run a gentle stream of water over the affected area for 15 minutes. A mild soap may be used if available. Contact a poison control center, emergency room or physician right away as further treatment will be necessary.

INHALATION:
Remove from area to fresh air. If symptomatic, contact a poison control center, emergency room or physician for treatment information.

INGESTION:
Gently wipe or rinse the inside of the mouth with water. Sips of water may be given if person is fully conscious. Never give anything by mouth to an unconscious or convulsing person. Do Not induce vomiting. Contact a poison control center, emergency room or physician right away as further treatment will be necessary.

SECTION 5 - FIRE FIGHTING MEASURES

FLAMMABLE PROPERTIES
FLASHPOINT: 230 Degrees F (110 Degrees C)
FLASHPOINT TEST METHOD:
Pensky-Martens Closed Cup
UEL: Not Available.
LEL: Not Available.
AUTOIGNITION TEMPERATURE:
Not Available.

EXTINGUISHING MEDIA:
Use National Fire Protection Association (NFPA) Class B extinguishers (carbon dioxide, dry chemical or universal aqueous film forming foam) designed to extinguish NFPA Class IIIB combustible liquid fires.
PROTECTION OF FIREFIGHTERS:
Water spray may be ineffective. Water spray may be used to cool closed containers that are exposed to extreme heat. If water is used, fog nozzles are preferable. Firefighters should wear self-contained breathing apparatus and full protective clothing.
UNUSUAL FIRE AND EXPLOSION HAZARDS:
Material not known to be explosive. Avoid using sodium nitrite or other nitrating agents in formulations containing this product. Nitrosamines, suspected of causing cancer, can be formed. May produce hazardous decomposition products when exposed to extreme heat. Extreme heat includes, but is not limited to, flame cutting, brazing, and welding.

SECTION 6 - ACCIDENTAL RELEASE MEASURE

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:
Provide maximum ventilation. Only personnel equipped with proper respiratory, skin, and eye protection should be permitted in the area. Remove all sources of ignition. Take up spilled material with sand, vermiculite, or other noncombustible absorbent material and place in clean, empty containers for disposal. Only the spilled material and the absorbant should be placed in this container.

SECTION 7 - HANDLING AND STORAGE

PRECAUTIONS TO BE TAKEN DURING HANDLING AND STORAGE:
If this material is part of a multiple component system, read the Material Safety Data Sheet(s) for the other component or components before blending as the resulting mixture may have the hazards of all of its parts.
STORAGE:
Do not store above 90 degrees F.(32 dgrees C.). Store large quantities in buildings designed and protected for storage of NFPA Class IIIB combustible liquids.

SECTION 8 - EXPOSURE CONTROLS & PERSONAL PROTECTION

ENGINEERING CONTROLS:
Provide general dilution or local exhaust ventilation in volume and pattern to keep the concentration of ingredients listed in Section 8 below the lowest suggested exposure limits, the LEL below the stated limit, and to remove decomposition products during welding or flame cutting.

PERSONAL PROTECTIVE EQUIPMENT
EYES:
Wear chemical-type splash goggles and full face shield when possibility exists for eye contact due to splashing or spraying liquid, airborne particles, or vapors.
SKIN/GLOVES:
Wear protective clothing sufficient to cover exposed skin surfaces. For applications where skin contact is likely and impermeable clothing is necessary, select clothing constructed of: rubber. No specific permeation/degradation testing have been done on protective clothing for this product. Recommendations for skin protection are based on infrequent contact with this product. For frequent contact or total immersion, contact a manufacturer of protective clothing for appropriate chemical impervious equipment. The decision whether to clean or discard contaminated clothing should be based on the chemicals contaminating them. Some chemicals can cause skin irritation, sensitization or other health effects if the cleaning process does not remove all traces of them. Consult a safety professional to determine whether clothing contaminated with this product can be safely cleaned and reused.

RESPIRATOR:
Overexposure to vapors may be prevented by ensuring proper ventilation controls, vapor exhaust or fresh air entry. A NIOSH- approved air purifying respirator with the appropriate chemical cartridges or a positive-pressure, air-supplied respirator may also reduce exposure. Read the respirator manufacturer's instructions and literature carefully to determine the type of airborne contaminants against which the respirator is effective, its limitations, and how it is to be properly fitted and used. Provide general dilution or local exhaust ventilation in volume and pattern to keep the concentration of ingredients listed in Section 2 below the lowest suggested exposure limits, the LEL below the stated limit, and to remove decomposition products during welding or flame cutting.
GENERAL HYGIENE - ESTABLISHED EXPOSURE LIMITS
If Threshold Limit Values (TLVs) have been established by ACGIH, OSHA, Ontario or PPG, they will be listed below. These limits are intended for use in the practice of industrial hygiene as guidelines or recommendations in the control of potential workplace health hazards. These limits are not a relative index of toxicity and should not be used by anyone without industrial hygiene training.

Material/ CAS Number	Percent	ACGIH TLV	ACGIH STEL	OSHA PEL	OSHA STEL
SILICA 7631-86-9	3 - 7	10 mg/m³	Not established	6 mg/m³	Not established
TITANIUM DIOXIDE 13463-67-7	1 - 5	10 mg/m³	Not established	10 mg/m³	Not established

Material/ CAS Number	Percent	Ontario TWA	Ontario STEL	PPG IPEL	PPG STEL
SILICA 7631-86-9	3 - 7	R- 0.10 MG/m³	Not established	Not established	Not established
TITANIUM DIOXIDE 13463-67-7	1 - 5	10 MG/m³	Not established	Not established	Not established

Key: ACGIH=American Conference of Governmental Industrial Hygienists; OSHA=Occupational Safety and Health Administration; TLV=Threshold Limit Value; TWA=Time Weighted Average; PEL=Permissible Exposure Limit (1989 Vacated values); IPEL=Internal Permissible Exposure Limit; Ceiling=TLV or PEL Ceiling Limit; STEL=TLV or PEL Short-Term Exposure Limit; Skin= Skin Absorption Designation. [C- Ceiling Limit; S-Potential Skin Absorption; R-Respirable Dust]
Additional Information Not applicable.

SECTION 9 - PHYSICAL & CHEMICAL PROPERTIES

(FORMULA VALUES, NOT SALES SPECIFICATIONS)

SPECIFIC GRAVITY:	1.055
PHYSICAL STATE:	Liquid
Percent Solids:	100.00
Percent Volatile by Volume:	.000
pH:	Not available.
ODOR THRESHOLD:	Not available.
Vapour Pressure:	N.A. mmHg
ODOR/APPEARANCE:	Viscous liquid with an odor characteristic of the solvents listed in Section 2.
VAPOR DENSITY:	HEAVIER THAN AIR
Evaporation Rate:	0
BOILING POINT OR RANGE:	Not available.
Freezing Point or Range:	Not Applicable.
Melting Point or Range(°C):	Not Applicable.
Partition coefficient (n-octanol/water):	Not Applicable.
WEIGHT PER GALLON:	8.79 (U.S.) / 10.5 (IMPERIAL)

SECTION 10 - STABILITY AND REACTIVITY

STABILITY:
This product is unstable and may contain ingredient(s) that react with incompatible materials, especially when heated.
CONDITIONS TO AVOID:
None Known.
INCOMPATIBLE MATERIALS:
Avoid contact with strong alkalies, strong mineral acids, or strong oxidizing agents.
HAZARDOUS POLYMERIZATION:
None Known.
HAZARDOUS DECOMPOSITION PRODUCTS:
- Carbon monoxide - Carbon dioxide - Oxides of nitrogen - Ammonia - Aldehydes - Amines

SECTION 11 - TOXICOLOGICAL INFORMATION

ACUTE TOXICITY

Material/ CAS Number	Percent	ORAL LD50 (g/kg)	DERMAL LD50 (g/kg)	INHALATION LC50 (mg/l)
POLYOXY PROPYLENE DIAMINE 9046-10-0	15 - 40	1.66 g/kg	.76 g/kg	Not Available
ASPARTIC ESTER Proprietary	10 - 30	2.00 g/kg	Not Available	4.92 mg/l 4 hr
TITANIUM DIOXIDE 13463-67-7	1 - 5	10.00 g/kg	Not Available	Not Available

CHRONIC TOXICITY
Ingredient Target Organ/Chronic Effects:
- Carcinogen - Lung - Metabolizes to carcinogen

Mutagenicity Toxicity:
This has not been tested for this product.
Reproductive Toxicity:
This has not been tested for this product.

SUPPLEMENTAL HEALTH INFORMATION:

Material/ CAS Number	Percent	Ingredient Specific Animal Data:
ALICYCLIC AMINE 156105-38-3	10 - 30	An ingredient in this product may be converted to nitrosamines in the body. Nitrosamines have produced tumors in laboratory animals by oral administration or by injection under the skin.
TITANIUM DIOXIDE 13463-67-7	1 - 5	This product contains titanium dioxide. Animals inhaling massive quantities of titanium dioxide dust in a long-term study developed lung tumors. Studies with humans involved in manufacture of this pigment indicate no increased risk of cancer from exposure.

SECTION 12 - ECOLOGICAL INFORMATION

POTENTIAL ENVIRONMENTAL EFFECTS
Ecotoxicity: No Information Available.

ENVIRONMENTAL FATE
Mobility: No information available.
Biodegradation: No information available.
Bioaccumulation: No Information Available.

PHYSICAL/CHEMICAL

Hydrolysis: No information available.
Photolysis: No information available.

SECTION 13 - DISPOSAL CONSIDERATIONS

Provide maximum ventilation, only personnel equipped with proper respiratory and skin and eye protection should be permitted in the area. Take up spilled material with sawdust, vermiculite, or other absorbent material and place in containers for disposal.
Waste material must be disposed of in accordance with federal, state, provincial and local environmental control regulations. Empty containers should be recycled by an appropriately licensed reconditioner/salvager or disposed of through a permitted waste management facility. Additional disposal information is contained on the Environmental Data Sheet for this product, which can be obtained from your PPG representative.

SECTION 14 - TRANSPORTATION INFORMATION

Proper Shipping Name: NOT AVAILABLE
NOS Technical Name: NOT AVAILABLE
Hazard Class: N.A.
Subsidiary Class(es): N.A.
UN Number: N.A.
Packing Group: N.A.

USA - RQ Hazardous Substances: NOT AVAILABLE
USA-RQ Hazardous Substance Threshold Ship Weight: NOT AVAILABLE
Marine Pollutant Name: NOT AVAILABLE

SECTION 15 - REGULATORY INFORMATION

INVENTORY STATUS
U.S. TSCA: This product and/or all of its components are listed on the U.S. TSCA Inventory or is otherwise exempt from TSCA Inventory reporting requirements.
FEDERAL REGULATIONS
US Regulations

Material/ CAS Number	Percent	CERCLA HS - RQ (LBS)	SARA EHS-TPQ (LBS)	SARA 313
POLYOXY PROPYLENE DIAMINE 9046-10-0	15 - 40	Not Listed	Not Listed	Not Listed
ASPARTIC ESTER Proprietary	10 - 30	Not Listed	Not Listed	Not Listed
ALICYCLIC AMINE 156105-38-3	10 - 30	Not Listed	Not Listed	Not Listed
SILICA 7631-86-9	3 - 7	Not Listed	Not Listed	Not Listed
TITANIUM DIOXIDE 13463-67-7	1 - 5	Not Listed	Not Listed	Not Listed

SARA 311/312
Health (acute): Yes
Health (chronic): Yes
Fire (flammable): No
Pressure: No
Reactivity: Yes
WHMIS HAZARD CLASS: - Class D, Division 2, Subdivision A - Class D, Division 2, Subdivision B - Class E - Class D, Division 1, Subdivision B

STATE/PROVINCIAL REGULATIONS
Additional Information

Material/ CAS Number	Percent	IARC Group 1(Known Human Carc.)	IARC Group 2A (Probable Carc.)	IARC 2B (Suspected Carc.)	ACGIH Carc.	NTP Known Carc.	OSHA Carc.
TITANIUM DIOXIDE 13463-67-7	1 - 5	N	N	Y	N	N	N

Key: IARC- International Agency on the Research of Cancer; ACGIH- American Conference of Governmental Industrial Hygienists; NTP- National Toxicology Program *Denotes chemical as NTP Known Carcinogen; + Denotes NTP Possible Carcinogen; OSHA- Occupational Safety and Health Administration.

SECTION 16 - OTHER INFORMATION

Hazard Rating Systems
NFPA Rating: 3 12
HMIS Rating: 3*12

Rating System: 0=Minimal, 1=Slight, 2=Moderate, 3=Serious, 4=Severe, *=Chronic Effects.

HMIS=Hazardous Materials Identification System; NFPA=National Fire Protection Association;

Safe handling of this product requires that all of the information on the MSDS be evaluated for specific work environments and conditions of use.

PREPARED BY: Product Safety Department
REASON FOR REVISION: Date. Edition.
Updated MSDS
format.

This Material Safety Data Sheet has been prepared in accordance with Canada's Workplace Hazardous Materials Information System (WHMIS) and the OSHA Hazard Communication Standard (29 CFR 1910.1200), the supplier notification requirements of SARA Title III, Section 313 and other applicable right-to-know regulations.
Additional environmental information is contained on the Environmental Data Sheet for this product, which can be obtained from your PPG representative.
BDL95617B 001002 (00511911.002)(04/15/08)
080410, 001, 0819

*** END OF MSDS ***

MATERIAL SAFETY DATA SHEET

SECTION 1 - PRODUCT AND COMPANY INFORMATION

PPG Industries, Inc.
One PPG Place
Pittsburgh, PA 15272

EMERGENCY PHONE NUMBERS (24 hours/day): **(412) 434-4515 (U.S.)**
(514) 645-1320 (Canada)
01-800-00-21-400 (Mexico)
0532-83889090 (China)

TECHNICAL INFORMATION: 1-800-245-2590 (CLEVELAND, OH) 8:00 a.m. - 5:00 p.m. EST
PRODUCT SAFETY/MSDS INFORMATION: (412) 492-5555 7:00 a.m. - 4:30 p.m. EST
Product ID: CAT137 (0806-T0)
PRODUCT NAME: CATALYST HARDENER
SYNONYMS: None
ISSUE DATE: 04/17/2008
EDITION NO.: 1
CHEMICAL FAMILY: ISOCYANATE

EMERGENCY OVERVIEW:
CAUSES IRREVERSIBLE EYE DAMAGE. MAY BE CORROSIVE. THIS PRODUCT CONTAINS A MATERIAL WHICH CAUSES SKIN BURNS. PROLONGED OR REPEATED CONTACT MAY CAUSE AN ALLERGIC SKIN REACTION.VAPOR AND/OR SPRAY MIST HARMFUL IF INHALED. MAY CAUSE IRRITATION AND/OR ALLERGIC RESPIRATORY REACTION IN LUNGS. SKIN CONTACT TO ISOCYANATE MONOMER MAY LEAD TO ALLERGIC LUNG REACTION.MAY BE HARMFUL IF SWALLOWED. STABLE - HAZARDOUS REACTIONS POSSIBLE AT EXTREMELY HIGH TEMPERATURES/PRESSURES. This product is not expected to present any unusual hazards under fire or spill conditions. Read entire MSDS before use.

SECTION 2 - COMPOSITION INFORMATION

The following ingredient(s) marked with an "x" are considered hazardous under applicable U.S. OSHA and/or Canadian WHMIS regulations. If no ingredients are listed, then there are no U.S. OSHA and/or Canadian WHMIS hazardous ingredients in this product.

Material/ CAS Number	Percent	Hazardous
URETHANE Proprietary	60- 100	X

SECTION 3 - HAZARDS IDENTIFICATION

ACUTE OVEREXPOSURE EFFECTS

EYE CONTACT:
This product contains a material which causes irreversible eye damage. Redness, itching, burning sensation and visual disturbances may indicate excessive eye contact.
SKIN CONTACT:
May be corrosive. This product contains a material which causes skin burns. Dryness, itching, cracking, burning, redness, and swelling are conditions associated with excessive skin contact.
SKIN ABSORPTION:
Skin absorption not expected to occur. Prolonged or repeated contact may cause an allergic skin reaction.
INHALATION:
Vapor and/or spray mist harmful if inhaled. May cause irritation and/or allergic respiratory reaction in lungs. Animal tests indicate that skin contact alone to monomeric isocyanates may lead to allergic respiratory reaction.
INGESTION:
May be harmful if swallowed.
SIGNS & SYMPTOMS OF OVEREXPOSURE:
Dryness, itching, cracking, burning, redness, and swelling are conditions associated with excessive skin contact.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Do not use if you have chronic (long-term) lung or breathing problems, or if you have ever had a reaction to isocyanates.
CHRONIC OVEREXPOSURE EFFECTS
Avoid long-term and repeated contact.
This product contains isocyanates. Inhalation may cause a burning sensation of the nose, throat and lungs. Allergic respiratory reactions to these materials are characterized by asthma-like symptoms such as chest tightness, wheezing, shortness of breath and coughing. These symptoms may follow repeated exposure or a single massive exposure and may be delayed.
The effects of long-term, low level exposures to this product have not been determined. Safe handling of this material on a long-term basis should emphasize the prevention of all contact with this material to avoid any effects from repetitive acute exposures. See Section 11, of this MSDS for a detailed list of chronic health effects information available on individual ingredients in this product.

SECTION 4 - FIRST AID MEASURES

If ingestion, irritation, any type of overexposure or symptoms of overexposure occur during or persists after use of this product, contact a POISON CONTROL CENTER, EMERGENCY ROOM OR PHYSICIAN immediately; have Material Safety Data Sheet information available.
EYE CONTACT:
Remove contact lens and pour a gentle stream of warm water through the affected eye for at least 15 minutes. Contact a poison control center, emergency room or physician right away as further treatment will be necessary.
SKIN CONTACT:
Run a gentle stream of water over the affected area for 15 minutes. A mild soap may be used if available. Contact a poison control center, emergency room or physician right away as further treatment will be necessary.
INHALATION:
Remove from area to fresh air. If symptomatic, contact a poison control center, emergency room or physician for treatment information.
INGESTION:
Gently wipe or rinse the inside of the mouth with water. Sips of water may be given if person is fully conscious. Never give anything by mouth to an unconscious or convulsing person. Do Not induce vomiting. Contact a poison control center, emergency room or physician right away as further treatment will be necessary.

SECTION 5 - FIRE FIGHTING MEASURES

FLAMMABLE PROPERTIES
FLASHPOINT: 201 Degrees F (94 Degrees C)
FLASHPOINT TEST METHOD:
Pensky-Martens Closed Cup
UEL: Not Available.
LEL: Not Available.
AUTOIGNITION TEMPERATURE:
Not Available.
EXTINGUISHING MEDIA:
Use National Fire Protection Association (NFPA) Class B extinguishers (carbon dioxide, dry chemical or universal aqueous film forming foam) designed to extinguish NFPA Class IIIB combustible liquid fires. Water spray may be ineffective. Water spray may be used to cool closed containers to prevent pressure build-up and possible autoignition or explosion when exposed to extreme heat.

PROTECTION OF FIREFIGHTERS:
Fire-fighters should wear self-contained breathing apparatus and full protective clothing.

UNUSUAL FIRE AND EXPLOSION HAZARDS:
Keep this product away from heat, sparks, flame, and other sources of ignition (i.e., pilot lights, electric motors, static electricity). Invisible vapors can travel to a source of ignition and flash back. Do not smoke while using this product. Keep containers tightly closed when not in use. Closed containers may explode when overheated. Do not apply to hot surfaces. Toxic gases may form when this product comes in contact with extreme heat. May produce hazardous decomposition products when exposed to extreme heat. Extreme heat includes, but is not limited to, flame cutting, brazing, and welding.

SECTION 6 - ACCIDENTAL RELEASE MEASURE

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:
Provide maximum ventilation. Only personnel equipped with proper respiratory, skin, and eye protection should be permitted in the area. Remove all sources of ignition. Take up spilled material with sand, vermiculite, or other noncombustible absorbent material and place in clean, empty containers for disposal. Only the spilled material and the absorbant should be placed in this container.

SECTION 7 - HANDLING AND STORAGE

PRECAUTIONS TO BE TAKEN DURING HANDLING AND STORAGE:
Vapors may collect in low areas. If this material is part of a multiple component system, read the Material Safety Data Sheet(s) for the other component or components before blending as the resulting mixture may have the hazards of all of its parts. Containers should be grounded when pouring. Avoid free fall of liquids in excess of a few inches.

STORAGE:
Do not store above 120 degrees F.(48 degress C.). Store large quantities in buildings designed and protected for storage of NFPA Class IIIB combustible liquids.

SECTION 8 - EXPOSURE CONTROLS & PERSONAL PROTECTION

ENGINEERING CONTROLS:
Provide general dilution or local exhaust ventilation in volume and pattern to keep the concentration of ingredients listed in Section 8 below the lowest suggested exposure limits, the LEL below the stated limit, and to remove decomposition products during welding or flame cutting.

PERSONAL PROTECTIVE EQUIPMENT

EYES:
Wear chemical-type splash goggles and full face shield when possibility exists for eye contact due to splashing or spraying liquid, airborne particles, or vapors.

SKIN/GLOVES:
Wear protective clothing sufficient to cover exposed skin surfaces. For applications where skin contact is likely and impermeable clothing is necessary, select clothing constructed of: impermeable material. No specific permeation/degradation testing have been done on protective clothing for this product. Recommendations for skin protection are based on infrequent contact with this product. For frequent contact or total immersion, contact a manufacturer of protective clothing for appropriate chemical impervious equipment. The decision whether to clean or discard contaminated clothing should be based on the chemicals contaminating them. Some chemicals can cause skin irritation, sensitization or other health effects if the cleaning process does not remove all traces of them. Consult a safety professional to determine whether clothing contaminated with this product can be safely cleaned and reused.

RESPIRATOR:
Where vapors or overspray are present, use a NIOSH approved, positive-pressure, air- supplied respirator for the entire time of spraying and until all vapors and mists are gone. Follow the respirator manufacturer's directions for respirator use. Provide general dilution or local exhaust ventilation in volume and pattern to keep the concentration of ingredients listed in Section 2 below the lowest suggested exposure limits, the LEL below the stated limit, and to remove decomposition products during welding or flame cutting.

GENERAL HYGIENE - ESTABLISHED EXPOSURE LIMITS
If Threshold Limit Values (TLVs) have been established by ACGIH, OSHA, Ontario or PPG, they will be listed below. These limits are intended for use in the practice of industrial hygiene as guidelines or recommendations in the control of potential workplace health hazards. These limits are not a relative index of toxicity and should not be used by anyone without industrial hygiene training.

Key: ACGIH=American Conference of Governmental Industrial Hygienists; OSHA=Occupational Safety and Health Administration; TLV=Threshold Limit Value; TWA=Time Weighted Average; PEL=Permissible Exposure Limit (1989 Vacated values); IPEL=Internal Permissible Exposure Limit; Ceiling=TLV or PEL Ceiling Limit; STEL=TLV or PEL Short-Term Exposure Limit; Skin= Skin Absorption Designation. [C- Ceiling Limit; S-Potential Skin Absorption; R-Respirable Dust]
Additional Information Not applicable.

SECTION 9 - PHYSICAL & CHEMICAL PROPERTIES
(FORMULA VALUES, NOT SALES SPECIFICATIONS)

SPECIFIC GRAVITY:	1.130
PHYSICAL STATE:	Liquid
Percent Solids:	99.98
Percent Volatile by Volume:	.030
pH:	Not available.
ODOR THRESHOLD:	Not available.
Vapour Pressure:	N.A. mmHg.
ODOR/APPEARANCE:	Viscous liquid with an odor characteristic of the solvents listed in Section 2.
VAPOR DENSITY:	HEAVIER THAN AIR
Evaporation Rate:	300
BOILING POINT OR RANGE:	180- 181Degrees F
Freezing Point or Range:	Not Applicable.
Melting Point or Range(°C):	Not Applicable.
Partition coefficient (n-octanol/water):	Not Applicable.
WEIGHT PER GALLON:	9.42 (U.S.) / 11.3 (IMPERIAL)

SECTION 10 - STABILITY AND REACTIVITY

STABILITY:
This product is normally stable but may undergo hazardous reactions at extremely high temperatures and pressures.

CONDITIONS TO AVOID:
None Known.

INCOMPATIBLE MATERIALS:
Avoid contact with strong alkalies, strong mineral acids, or strong oxidizing agents. Avoid water and alcohols.

HAZARDOUS POLYMERIZATION:
None Known.

HAZARDOUS DECOMPOSITION PRODUCTS:
- Carbon monoxide - Carbon dioxide - Traces of isocyanate - Oxides of nitrogen - Hydrogen cyanide - Lower molecular weight polymer fractions

SECTION 11 - TOXICOLOGICAL INFORMATION

ACUTE TOXICITY

CHRONIC TOXICITY
Ingredient Target Organ/Chronic Effects:
- Respiratory sensitizer

Mutagenicity Toxicity:
This has not been tested for this product.
Reproductive Toxicity:
This has not been tested for this product.

SUPPLEMENTAL HEALTH INFORMATION:

SECTION 12 - ECOLOGICAL INFORMATION

POTENTIAL ENVIRONMENTAL EFFECTS
Ecotoxicity: No Information Available.

ENVIRONMENTAL FATE
Mobility: No information available.
Biodegradation: No information available.
Bioaccumulation: No Information Available.

PHYSICAL/CHEMICAL

Hydrolysis: No information available.
Photolysis: No information available.

SECTION 13 - DISPOSAL CONSIDERATIONS

Provide maximum ventilation, only personnel equipped with proper respiratory and skin and eye protection should be permitted in the area. Take up spilled material with sawdust, vermiculite, or other absorbent material and place in containers for disposal.
Waste material must be disposed of in accordance with federal, state, provincial and local environmental control regulations. Empty containers should be recycled by an appropriately licensed reconditioner/salvager or disposed of through a permitted waste management facility. Additional disposal information is contained on the Environmental Data Sheet for this product, which can be obtained from your PPG representative.

SECTION 14 - TRANSPORTATION INFORMATION

Proper Shipping Name: NOT AVAILABLE
NOS Technical Name: NOT AVAILABLE
Hazard Class: N.A.
Subsidiary Class(es): N.A.
UN Number: N.A.
Packing Group: N.A.

USA - RQ Hazardous Substances: NOT AVAILABLE
USA-RQ Hazardous Substance Threshold Ship Weight: NOT AVAILABLE
Marine Pollutant Name: NOT AVAILABLE

SECTION 15 - REGULATORY INFORMATION

INVENTORY STATUS
U.S. TSCA: This product and/or its component are not listed on the U. S. TSCA inventory. This product is being offered for R & D purposes only. Contact your PPG representative for further details.
FEDERAL REGULATIONS
US Regulations

Material/ CAS Number	Percent	CERCLA HS - RQ (LBS)	SARA EHS- TPQ (LBS)	SARA 313
URETHANE Proprietary	60- 100	Not Listed	Not Listed	Not Listed

SARA 311/312
Health (acute): Yes
Health (chronic): Yes
Fire (flammable): No
Pressure: No
Reactivity: No
WHMIS HAZARD CLASS: - Class D, Division 2, Subdivision A - Class D, Division 2, Subdivision B - Class E

STATE/PROVINCIAL REGULATIONS
Additional Information
Key: IARC- International Agency on the Research of Cancer; ACGIH- American Conference of Governmental Industrial Hygienists; NTP- National Toxicology Program *Denotes chemical as NTP Known Carcinogen; + Denotes NTP Possible Carcinogen; OSHA- Occupational Safety and Health Administration.

SECTION 16 - OTHER INFORMATION

Hazard Rating Systems
NFPA Rating: 3 1 1
HMIS Rating: 3*1 1

Rating System: 0=Minimal, 1=Slight, 2=Moderate, 3=Serious, 4=Severe, *=Chronic Effects.

HMIS=Hazardous Materials Identification System; NFPA=National Fire Protection Association;

Safe handling of this product requires that all of the information on the MSDS be evaluated for specific work environments and conditions of use.

PREPARED BY: Product Safety Department
REASON FOR REVISION: Date. Edition. Updated MSDS format.

This Material Safety Data Sheet has been prepared in accordance with Canada's Workplace Hazardous Materials Information System (WHMIS) and the OSHA Hazard Communication Standard (29 CFR 1910.1200), the supplier notification requirements of SARA Title III, Section 313 and other applicable right-to-know regulations.
Additional environmental information is contained on the Environmental Data Sheet for this product, which can be obtained from your PPG representative.
CAT137 000000 (00512057.001)(04/16/08)
080415, 000, 0806

*** END OF MSDS ***

Architectural Coatings — **SPEEDHIDE® Interior Fire Retardant Flat Latex**

Generic Type

Modified Polyvinyl Acetate Latex

General Description

SPEEDHIDE® Interior Fire Retardant Latex is formulated to meet the performance requirements of professional application. Recommended for the protection and decoration of combustible interior wall and ceiling surfaces such as wood, wallboard, plywood, particle board, and similar surfaces. May also be used on cement board if desired. The paint film intumesces when exposed to flame or high temperatures.

Recommended Uses

Cement Board
Wallboard
Wood

Features / Benefits

Protects Combustible Surfaces
Fulfills Class A Rating Established by the National Fire Protection Association
Meets Most Local and State Fire Laws
Passed ASTM E-84, NFPA 255, UL 723
Meets Mine Safety & Health Administration Regulations
Meets MPI category #64, Interior Latex Fire Retardant Flat Coating
Can earn LEED NC Version 2.2 Credits

Limitations of Use

Apply when air, product, and surface temperatures are above 50°F (10°C). Not recommended for application over "foam" type insulations. Not recommended for use on floors. Do not use where continuous dampness exists. PROTECT FROM FREEZING. Drying times listed may vary depending on temperature, humidity, color and air movement.

Tinting and Base Information

Use PITTSBURGH® Paints Custom Colorants and refer to THE VOICE OF COLOR® formula book for tinting instructions.

42-7 White

Product Data

Gloss: Flat: 0 to 5 (60 & 85°Gloss Meter)
VOC*: 0.27 lbs/gal (32.40 g/L)
DFT: 2.40 minimum to 5.40 maximum mils
Coverage: 150 to 335 sq. ft./gal. (13 to 31 sq. m/3.78L)
Note: Does not include loss due to varying application method, surface porosity, or mixing.
Volume Solids*: 50.2% +/- 2.0%
Weight Solids*: 61.7% +/- 2.0%
Viscosity: 85 to 95 KU
Weight/Gallon*: 10.8 lbs. (4.9 kg) +/- 0.2 lbs. (91 g)
Cleanup: Soap and Water
*Product data calculated on product 42-7.

Drying Time:

To Touch:	30 minutes
To Handle:	4 hours
To Recoat:	4 hours
To Full Cure:	30 days

Dry Time @77°F (25°C); 50% relative humidity

Flash Point: Over 200°F, (93°C)

Architectural Coatings **SPEEDHIDE® Interior Fire Retardant Flat Latex**

General Surface Preparation

Surface must be free of grease, dirt, rust, and loose or powdery paint. Water sensitive coatings including calcimine must be completely removed. Repair cracks and gouges with patching compound. Sand these smooth and remove all dust. Previously painted glossy or slick surfaces must be thoroughly cleaned with strong detergents to remove surface soils and contaminates. To promote adhesion, surface sheen should be removed or reduced by rubbing with sandpaper. To meet UL rating, SPEEDHIDE® Interior Fire Retardant Flat Latex is self-priming on bare wood. WARNING! If you scrape, sand, or remove old paint, you may release lead dust or fumes. LEAD IS TOXIC. EXPOSURE TO LEAD DUST OR FUMES CAN CAUSE SERIOUS ILLNESS, SUCH AS BRAIN DAMAGE, ESPECIALLY IN CHILDREN. PREGNANT WOMEN SHOULD ALSO AVOID EXPOSURE. Wear a properly fitted NIOSH-approved respirator and prevent skin contact to control lead exposure. Clean up carefully with a HEPA vacuum and a wet mop. Before you start, find out how to protect yourself and your family by contacting the USEPA National Lead Information Hotline at 1-800-424-LEAD or log on to www.epa.gov/lead. In Canada contact a regional Health Canada office. Follow these instructions to control exposure to other hazardous substances that may be released during surface preparation.

Recommended Primers

none	Refer to Surface Preparation Recommendations.

Directions for Use

Stir thoroughly before using and occasionally when in use. When using more than one can of the same color, mix together (box) before applying. USE WITH ADEQUATE VENTILATION. KEEP OUT OF REACH OF CHILDREN. Read all label and Material Safety Data Sheet (MSDS) information prior to use. MSDS are available through our website or by calling 1-800-441-9695.

Permissible temperatures during application:

Material:	50 to 90°F	10 to 32°C
Ambient:	50 to 100°F	10 to 38°C
Substrate:	50 to 100°F	10 to 38°C

Application Information

Recommended Spread Rates:

Wet Mils :	4.8 minimum to	10.8 maximum
Wet Microns:	121.9 minimum to	274.3 maximum
Dry Mils :	2.4 minimum to	5.4 maximum
Dry Microns:	61.0 minimum to	137.2 maximum

Application Equipment: Apply with a high quality brush, roller, paint pad, or by spray equipment. Where necessary, apply a second coat. Spray equipment must be handled with due care and in accordance with manufacturer's recommendation. High-pressure injection of coatings into the skin by airless equipment may cause serious injury.

Airless Spray: Pressure 2400 psi, 60 mesh filter
Brush: Polyester/Nylon Brush
Roller: 3/8" - 3/4" nap roller cover.

Thinning:
No thinning is recommended. Up to 1/2 pint of water (237 mL) per U.S. Gallon (3.78L) may be added for brush/roller applications. For conventional spray, up to one pint (473 mL) of water per U.S. gallon (3.78L)may be added.

Packaging: 1-Gallon (3.78L)
5-Gallon (18.9L)

Not all products are available in all sizes.

PPG Industries, Inc.
Architectural Coatings
One PPG Place
Pittsburgh, PA 15272
www.pittsburghpaints.com

Technical Services
1-800-441-9695
1-888-807-5123 fax

Architect/Specifier
1-888-PPG-IDEA

PPG Architectural Finishes
400 S. 13th Street
Louisville, KY 40203

PPG Canada, Inc.
Architectural Coatings
4 Kenview Blvd
Brampton, ON L6T 5E4

MATERIAL SAFETY DATA SHEET

SECTION 1 - PRODUCT AND COMPANY INFORMATION

PPG Industries, Inc.
One PPG Place
Pittsburgh, PA 15272

EMERGENCY PHONE NUMBERS (24 hours/day): (412) 434-4515 (U.S.)
(514) 645-1320 (Canada)
01-800-00-21-400 (Mexico)
0532-83889090 (China)

PRODUCT SAFETY/MSDS INFORMATION: (412) 492-5555 7:00 a.m. - 4:30 p.m. EST

Product ID: 42-7 (0822-F1)
PRODUCT NAME: LATEX FIRE RETARDANT PAI
SYNONYMS: None
ISSUE DATE: 05/30/2007
EDITION NO.: 2
CHEMICAL FAMILY: Polyvinyl Acetate Melamin

EMERGENCY OVERVIEW:
CAUSES EYE IRRITATION. MAY CAUSE MODERATE SKIN IRRITATION. MAY BE ABSORBED THROUGH THE SKIN.VAPOR AND/OR SPRAY MIST MAY BE HARMFUL IF INHALED.HARMFUL OR FATAL IF SWALLOWED.

SECTION 2 - COMPOSITION INFORMATION

The following ingredient(s) marked with an "x" are considered hazardous under applicable U.S. OSHA and/or Canadian WHMIS regulations. If no ingredients are listed, then there are no U.S. OSHA and/or Canadian WHMIS hazardous ingredients in this product.

Material/ CAS Number	Percent	Hazardous
PENTAERYTHRITOL 115-77-5	5 - 10	X
TITANIUM DIOXIDE 13463-67-7	1 - 5	X
CHLORINATED POLYOLEFIN 68410-99-1	1 - 5	X
PHOSPHATE ESTER Proprietary	0.5-1.5	X
VINYL ACETATE 108-05-4	0.1-1.0	X

SECTION 3 - HAZARDS IDENTIFICATION

ACUTE OVEREXPOSURE EFFECTS

EYE CONTACT:
Causes eye irritation. Redness, itching, burning sensation and visual disturbances may indicate excessive eye contact.
SKIN CONTACT:
May cause moderate skin irritation. Dryness, itching, cracking, burning, redness, and swelling are conditions associated with excessive skin contact.
SKIN ABSORPTION:
May be absorbed through the skin.
INHALATION:
Vapor and/or spray mist may be harmful if inhaled.
INGESTION:
Harmful or fatal if swallowed.
SIGNS & SYMPTOMS OF OVEREXPOSURE:
None Known.

MEDICAL CONDITIONS AGGRAVATED BY EXPOSURE: Not applicable.
CHRONIC OVEREXPOSURE EFFECTS
Avoid long-term and repeated contact.
The effects of long-term, low level exposures to this product have not been determined. Safe handling of this material on a long-term basis should emphasize the prevention of all contact with this material to avoid any effects from repetitive acute exposures. See Section 11, of this MSDS for a detailed list of chronic health effects information available on individual ingredients in this product.

SECTION 4 - FIRST AID MEASURES

If ingestion, irritation, any type of overexposure or symptoms of overexposure occur during or persists after use of this product, contact a POISON CONTROL CENTER, EMERGENCY ROOM OR PHYSICIAN immediately; have Material Safety Data Sheet information available.
EYE CONTACT:
Remove contact lens and pour a gentle stream of warm water through the affected eye for at least 15 minutes. If irritation persists, contact a poison control center, emergency room, or physician as further treatment may be necessary.
SKIN CONTACT:
Run a gentle stream of water over the affected area for 15 minutes. A mild soap may be used if available. If any symptoms persist, contact a poison control center, emergency room, or physician as further treatment may be necessary.
INHALATION:
Remove from area to fresh air. If symptomatic, contact a poison control center, emergency room or physician for treatment information.
INGESTION:
Gently wipe or rinse the inside of the mouth with water. Sips of water may be given. Never give anything by mouth to an unconscious person. Contact a poison control center, emergency room or physician right away as further treatment may be necessary.

SECTION 5 - FIRE FIGHTING MEASURES

FLAMMABLE PROPERTIES
FLASHPOINT: >200 Degrees F (> 93 Degrees C)
FLASHPOINT TEST METHOD:
Pensky-Martens Closed Cup
UEL: Not Available.
LEL: Not Available.
AUTOIGNITION TEMPERATURE:
Not Available.
EXTINGUISHING MEDIA:
Use extinguishers appropriate for surrounding fire.
PROTECTION OF FIREFIGHTERS:
Water spray may be ineffective. Water spray may be used to cool closed containers that are exposed to extreme heat. If water is used, fog nozzles are preferable. Firefighters should wear self-contained breathing apparatus and full protective clothing.

SECTION 6 - ACCIDENTAL RELEASE MEASURE

STEPS TO BE TAKEN IF MATERIAL IS RELEASED OR SPILLED:
None Known.

SECTION 7 - HANDLING AND STORAGE

PRECAUTIONS TO BE TAKEN DURING HANDLING AND STORAGE:
NA
STORAGE:
None Known.

SECTION 8 - EXPOSURE CONTROLS & PERSONAL PROTECTION

ENGINEERING CONTROLS:
Provide general dilution or local exhaust ventilation in volume and pattern to keep the concentration of ingredients listed in Section 8 below the lowest suggested exposure limits, the LEL below the stated limit, and to remove decomposition products during welding or flame cutting.

PERSONAL PROTECTIVE EQUIPMENT

EYES:
Wear chemical-type splash goggles when possibility exists for eye contact due to splashing or spraying liquid, airborne particles, or vapors.
SKIN/GLOVES:
Wear protective clothing to prevent skin contact. Apron and gloves should be constructed of: neoprene rubber or nitrile rubber. No specific permeation/degradation testing have been done on protective clothing for this product. Recommendations for skin protection are based on infrequent contact with this product. For frequent contact or total immersion, contact a manufacturer of protective clothing for appropriate chemical impervious equipment. Clean contaminated clothing and shoes.
RESPIRATOR:
Where vapors are present, an appropriate NIOSH-approved air purifying respirator with organic vapor cartridges or positive- pressure, air-supplied respirator is required. Read the respirator manufacturer's instructions and literature carefully to determine the type of airborne contaminants against which the respirator is effective, its limitations, and how it is to be properly fitted and used. Provide general dilution or local exhaust ventilation in volume and pattern to keep the concentration of ingredients listed in Section 2 below the lowest suggested exposure limits, the LEL below the stated limit, and to remove decomposition products during welding or flame cutting.
GENERAL HYGIENE - ESTABLISHED EXPOSURE LIMITS
If Threshold Limit Values (TLVs) have been established by ACGIH, OSHA, Ontario or PPG, they will be listed below. These limits are intended for use in the practice of industrial hygiene as guidelines or recommendations in the control of potential workplace health hazards. These limits are not a relative index of toxicity and should not be used by anyone without industrial hygiene training.

Material/ CAS Number	Percent	ACGIH TLV	ACGIH STEL	OSHA PEL	OSHA STEL
PENTAERYTHRITOL 115-77-5	5 - 10	10 mg/m³	Not established	R- 5 mg/m³	Not established
TITANIUM DIOXIDE 13463-67-7	1 - 5	10 mg/m³	Not established	10 mg/m³	Not established
VINYL ACETATE 108-05-4	0.1-1.0	10 ppm	15 ppm	10 ppm	20 ppm

Material/ CAS Number	Percent	Ontario TWA	Ontario STEL	PPG IPEL	PPG STEL
PENTAERYTHRITOL 115-77-5	5 - 10	10 MG/m³	Not established	Not established	Not established
TITANIUM DIOXIDE 13463-67-7	1 - 5	10 MG/m³	Not established	Not established	Not established
VINYL ACETATE 108-05-4	0.1-1.0	10 PPM	15 PPM	Not established	Not established

Key: ACGIH=American Conference of Governmental Industrial Hygienists; OSHA=Occupational Safety and Health Administration; TLV=Threshold Limit Value; TWA=Time Weighted Average; PEL=Permissible Exposure Limit (1989 Vacated values); IPEL=Internal Permissible Exposure Limit; Ceiling=TLV or PEL Ceiling Limit; STEL=TLV or PEL Short-Term Exposure Limit; Skin= Skin Absorption Designation. [C- Ceiling Limit; S-Potential Skin Absorption; R-Respirable Dust]
Additional Information Not applicable.

SECTION 9 - PHYSICAL & CHEMICAL PROPERTIES (FORMULA VALUES, NOT SALES SPECIFICATIONS)

SPECIFIC GRAVITY:	1.302
PHYSICAL STATE:	Not available.
Percent Solids:	61.68
Percent Volatile by Volume:	49.820
pH:	Not available.
ODOR THRESHOLD:	Not available.
Vapour Pressure:	17.3 mmHg
ODOR/APPEARANCE:	Not available.
VAPOR DENSITY:	HEAVIER THAN AIR
Evaporation Rate:	35
BOILING POINT OR RANGE:	212 - 450Degrees F
Freezing Point or Range:	Not Applicable.
Melting Point or Range(°C):	Not Applicable.
Partition coefficient (n-octanol/water):	Not Applicable.
WEIGHT PER GALLON:	10.85 (U.S.) / 13.0 (IMPERIAL)

SECTION 10 - STABILITY AND REACTIVITY

STABILITY:
None Known.
CONDITIONS TO AVOID:
None Known.
INCOMPATIBLE MATERIALS:
None Known.
HAZARDOUS POLYMERIZATION:
None Known.
HAZARDOUS DECOMPOSITION PRODUCTS:
- None known

SECTION 11 - TOXICOLOGICAL INFORMATION

ACUTE TOXICITY

Material/ CAS Number	Percent	ORAL LD50 (g/kg)	DERMAL LD50 (g/kg)	INHALATION LC50 (mg/l)
PENTAERYTHRITOL 115-77-5	5 - 10	19.50 g/kg	Not Available	Not Available
TITANIUM DIOXIDE 13463-67-7	1 - 5	10.00 g/kg	Not Available	Not Available
VINYL ACETATE 108-05-4	0.1-1.0	2.50 g/kg	Not Available	14.08 mg/l 4 hr

CHRONIC TOXICITY
Ingredient Target Organ/Chronic Effects:
- None known
Mutagenicity Toxicity:
This has not been tested for this product.
Reproductive Toxicity:
This has not been tested for this product.

SUPPLEMENTAL HEALTH INFORMATION:

Material/ CAS Number	Percent	Ingredient Specific Animal Data:
TITANIUM DIOXIDE 13463-67-7	1 - 5	This product contains titanium dioxide. Animals inhaling massive quantities of titanium dioxide dust in a long-term study developed lung tumors. Studies with humans involved in manufacture of this pigment indicate no increased risk of cancer from exposure.

SECTION 12 - ECOLOGICAL INFORMATION

POTENTIAL ENVIRONMENTAL EFFECTS

Ecotoxicity:	No Information Available.

ENVIRONMENTAL FATE

Mobility:	No information available.
Biodegradation:	No information available.
Bioaccumulation:	No Information Available.

PHYSICAL/CHEMICAL

Hydrolysis: No information available.
Photolysis: No information available.

SECTION 13 - DISPOSAL CONSIDERATIONS

Waste material must be disposed of in accordance with federal, state, provincial and local environmental control regulations. Empty containers should be recycled by an appropriately licensed reconditioner/salvager or disposed of through a permitted waste management facility. Additional disposal information is contained on the Environmental Data Sheet for this product, which can be obtained from your PPG representative.

SECTION 14 - TRANSPORTATION INFORMATION

Proper Shipping Name: Paint- Non-Regulated Goods
NOS Technical Name: None
Hazard Class: None
Subsidiary Class(es): None
UN Number: None
Packing Group: None

USA - RQ Hazardous Substances: None
USA-RQ Hazardous Substance Threshold Ship Weight: None
Marine Pollutant Name: None

SECTION 15 - REGULATORY INFORMATION

INVENTORY STATUS
FEDERAL REGULATIONS
US Regulations

Material/ CAS Number	Percent	CERCLA HS - RQ (LBS)	SARA EHS- TPQ (LBS)	SARA 313
PENTAERYTHRITOL 115-77-5	5 - 10	Not Listed	Not Listed	Not Listed
TITANIUM DIOXIDE 13463-67-7	1 - 5	Not Listed	Not Listed	Not Listed
CHLORINATED POLYOLEFIN 68410-99-1	1 - 5	Not Listed	Not Listed	Not Listed
PHOSPHATE ESTER Proprietary	0.5-1.5	Not Listed	Not Listed	Not Listed
VINYL ACETATE 108-05-4	0.1-1.0	5000 lbs	1000 LB	Listed

SARA 311/312
Health (acute): Yes
Health (chronic): Yes
Fire (flammable): No
Pressure: No
Reactivity: No
WHMIS HAZARD CLASS: - Class D, Division 2, Subdivision A

STATE/PROVINCIAL REGULATIONS
Additional Information

Material/ CAS Number	Percent	IARC Group 1(Known Human Carc.)	IARC Group 2A (Probable Carc.)	IARC 2B (Suspected Carc.)	ACGIH Carc.	NTP Known Carc.	OSHA Carc.
TITANIUM DIOXIDE 13463-67-7	1 - 5	N	N	Y	N	N	N
VINYL ACETATE 108-05-4	0.1-1.0	N	N	Y	N	N	Y

Key: IARC- International Agency on the Research of Cancer; ACGIH- American Conference of Governmental Industrial Hygienists; NTP- National Toxicology Program *Denotes chemical as NTP Known Carcinogen; + Denotes NTP Possible Carcinogen; OSHA- Occupational Safety and Health Administration.

SECTION 16 - OTHER INFORMATION

Hazard Rating Systems
NFPA Rating: 2 1 0
HMIS Rating: 2*1 0

Rating System: 0=Minimal, 1=Slight, 2=Moderate, 3=Serious, 4=Severe, *=Chronic Effects.

HMIS=Hazardous Materials Identification System; NFPA=National Fire Protection Association;

Safe handling of this product requires that all of the information on the MSDS be evaluated for specific work environments and conditions of use.

PREPARED BY: Product Safety Department
REASON FOR REVISION: Section 13 has been updated. Section 5 has been updated. Section 7 has been updated. Section 10 has been updated. Section 4 has been updated. Section 15 has been updated. Section 1 has been updated. Section 9 has been updated. Section 3 has been updated. Section 6 has been updated. Section 11 has been updated. Section 8 has been updated. Date. Edition. Updated MSDS format.

This Material Safety Data Sheet has been prepared in accordance with Canada's Workplace Hazardous Materials Information System (WHMIS) and the OSHA Hazard Communication Standard (29 CFR 1910.1200), the supplier notification requirements of SARA Title III, Section 313 and other applicable right-to-know regulations.
Additional environmental information is contained on the Environmental Data Sheet for this product, which can be obtained from your PPG representative.
42-7 001020 (00328120.005)(05/29/07)
040126, 001, 0822

*** END OF MSDS ***

Appendix F

Polyurea Coating for Mine Seal Trial Industrial Hygiene Sampling Report

Polyurea Coating for Mine Seal Trial
Industrial Hygiene Sampling Report

Industrial hygiene air samples were collected during two tests of a polyurea coating for mine seal applications conducted at the Lake Lynn Experimental Mine on December 19, 2007. The Lake Lynn Experimental Mine is a limestone mine managed by NIOSH. The PPG product used for this trial was a two component Polyurea White Coating (PPG Product Codes 07-MFR-042 and HR-35-8094)[1]. During these tests, the mine ventilation air flow was varied using blower speed and brattice cloths to represent conditions of low air flow (20 fpm at seal) and high air flow (250 fpm at the seal).

Industrial hygiene area samples were collected and analyzed for inhalable particulate (IOM – Institute of Occupational Medicine – inhalable fraction), hexamethylene di-isocyanate (HDI) monomer and HDI polymer. Personal samples were collected for HDI monomer and polymer on the sprayer and assistant during both tests.

Occupational Exposure Limits (OEL) utilized for these materials are listed below:

Material	1973 ACGIH® (TLV®)	2007 ACGIH® (TLV®)	PPG – Guideline
Particulates – Inhalable	10 mg/m3 (TWA)	10 mg/m3 (TWA)	(Use 2007 or current ACGIH TLV)
HDI	Not established	5 ppb (TWA)	15 ppb (STEL)
HDI polymer	Not established	Not established	1 mg/m3 (STEL)

The ACGIH® TLV®[2]s "refer to airborne concentrations of chemical substances and represent conditions under which it is believed that nearly all workers may be repeatedly exposed, day after day, over a working lifetime, without adverse health effects." [3] The TLVs® are exposure guidelines for use by health professionals in making decisions regarding safe levels of exposure to various chemical and physical agents found in the work place.

Two categories of exposure limits are referenced in this report. The Time Weighted Average (TWA) which is used as a guide for 8-hour workday, and 40-hour workweek exposures, and the Short Term Exposure Limit (STEL) a 15 minute TWA exposure that should not be exceeded during the workday. The STEL is the concentration to which it is believed that workers can be exposed continuously for a short period of time, up to 15 minutes.

It is important to note that MSHA (Mine Safety and Health Administration) utilizes 1973 ACGIH ®TLVs®. The 1973 ACGIH TLVs® do not include exposure limits for HDI monomer or polymer. The 2007 ACGIH® TLV® includes a TWA for HDI monomer, but not for the oligomer. PPG has established a short term exposure guideline (STEL) for HDI monomer, and a STEL for HDI polymer. The STEL exposure guidelines were utilized when available for this report since the air samples collected, while not 15 minutes in duration, were less than 30 minutes in duration.

Air Sampling Results

The air sampling results are provided in the table below along with a normalized exposure factor in which the air sample result is displayed as a fraction of the exposure limit. (The measured exposures were divided by the exposure limit and expressed as a factor of 1. Normalized exposures greater than 1 indicate that the exposure

---

[1] Subsequent to this trial, the product formulation has changed and may undergo further modification. The results contained in this report are specific to the conditions noted within this report.
[2] The American Conference of Governmental Industrial Hygienists Threshold Limit Values
[3] 2007 TLV®s and BEI®s Based on the Documentation of the Threshold Limit Values for Chemical Substances and Physical Agents & Biological Exposure Indices, Signature Publications, 2007.

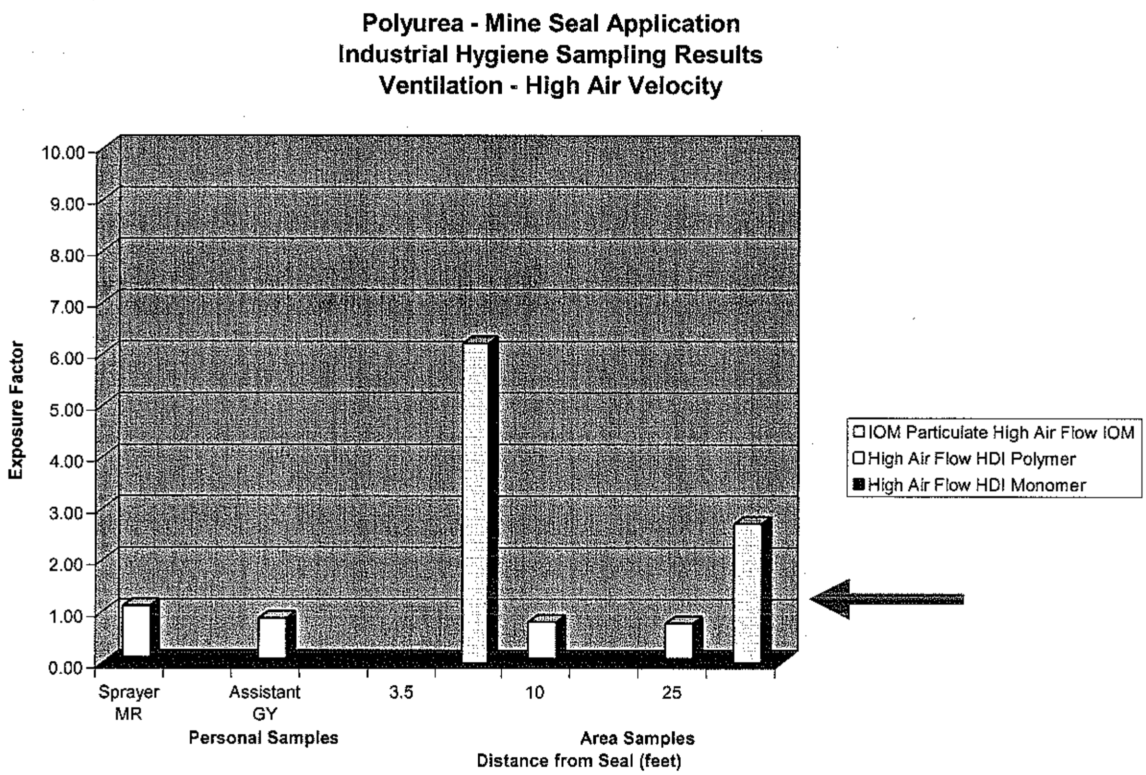
guideline was exceeded, and normalized exposures less than 1 indicate that the measured exposure did not exceed the exposure guideline.) The HDI monomer and HDI polymer were combined into a mixture value since these materials have similar effects. Values less than 1.0 are below the OEL, and values above 1.0 indicate that the sampling result exceeded the OEL. The air sampling results are also displayed graphically in the bar charts included in this report. The OEL is noted in the charts with a red arrow.

The sprayer and the assistant were sampled for HDI monomer and polymer during both tests (high air velocity and low air velocity). Area samples for IOM particulate and HDI monomer and polymer were collected at measured positions relative to the application site.

Ventilation – High Air Velocity (20 minute test duration)

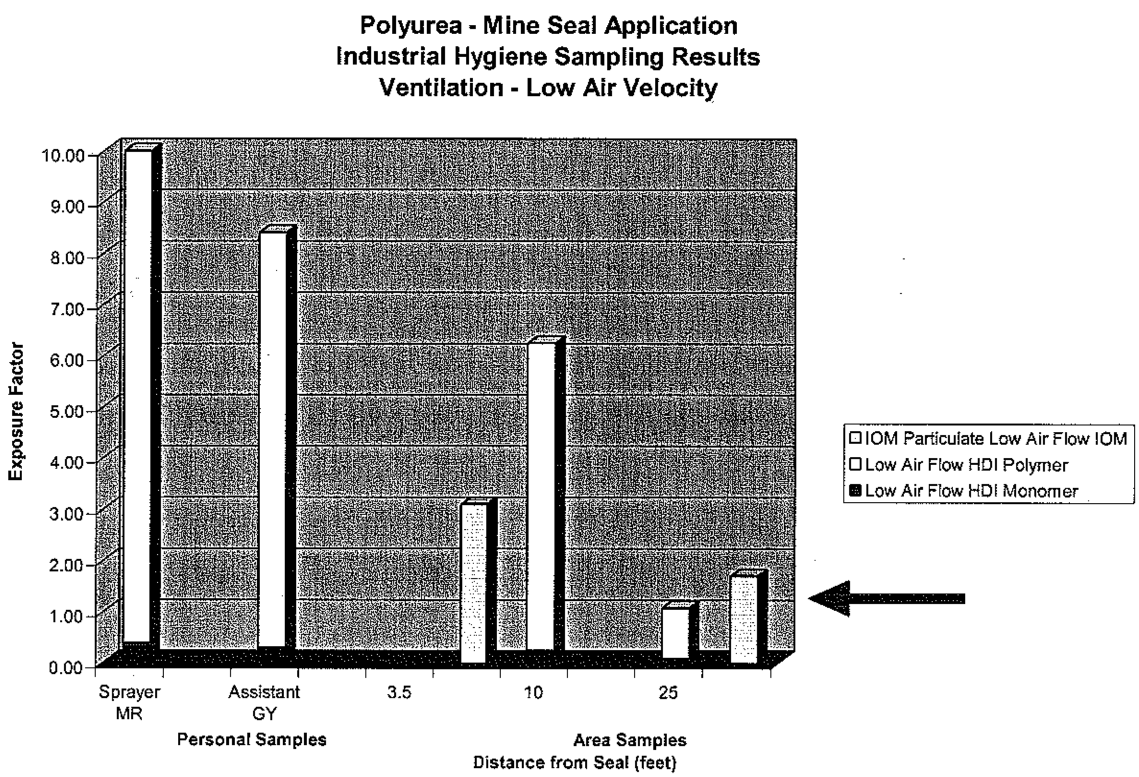
Position or Distance from Application	IOM – Particulate (mg/m3)	Particulate Exposure Factor	HDI Monomer (ppb)	HDI Monomer Exposure Factor	HDI Polymer (mg/m3)	HDI Polymer Exposure Factor	HDI Mixture Exposure Factor
Sprayer			<1.7	<0.11	1	1	1.1
Assistant			<1.3	<0.09	.78	.78	.84
3.5 ft	62	6.2					
10 ft			<1.4	<0.09	.71	.71	.78
25 ft	27	2.7	<1.3	<0.09	.68	.68	.74

< indicates less than stated detection limit



Ventilation – Low Air Velocity (20 minute test duration)

Position or Distance from Application	IOM – Particulate (mg/m3)	Particulate Exposure Factor	HDI Monomer (ppb)	HDI Monomer Exposure Factor	HDI Polymer (mg/m3)	HDI Polymer Exposure Factor	HDI Exposure Factor
Sprayer			5.9	.39	9.7	9.7	10
Assistant			4.7	.31	8.1	8.1	8.4
3.5 ft	31	3.1					
10 ft			3.8	.25	6	6	6.3
25 ft	17	1.7	1.4	.09	.99	.99	1.1



Area Sample Summary-

During both trials, the inhalable particulate exceeded the OEL. HDI monomer was not detected during the trial with high air flow, and did not exceed the OEL during the trial with low air flow. HDI polymer was measured below the OEL during the trial with high air flow, and exceeded the OEL by 1-6 times during the trial with low air flow.

Personal Sample Summary –

Inhalable particulate sampling was not performed for personal samples. HDI monomer was not detected during the spray test with high air flow, and was below the OEL during the test with low air flow. HDI polymer was at the OEL during the spray test with high air flow, and exceeded the OEL by 8-10 times during the trial with low air flow.

Personal Protective Equipment

Based upon these measurements, personal protective equipment (PPE) needs to be worn during the mine seal preparation and application in the spray zone to prevent inhalation and skin contact with the polyurea coating. The selection of PPE must be part of a site hazard evaluation, consistent with regulatory requirements and the product safety data sheets. Based upon this test, the recommended PPE for this worksite includes the following:

- Chemically Resistant Disposable Coveralls
- Chemically Resistant Gloves
- Foot Protection
- Full Face Respiratory Protection (air supply or powered air purifying with a minimum protection factor of 25 for particulate and organic vapors). It is important that a respiratory protection program which includes powered air purifying cartridge change-out schedules be established in compliance with regulatory requirements. The respirator manufacturer is a recommended resource to assist with respiratory selection and use.

PPE should be worn during the application and for a period of at least 15 minutes after the cessation of the spraying action, in accordance with the Coal Mine Health Inspection Procedures Handbook.

The above PPE is in addition to protective equipment required for mine entry.

Establishing and Estimating a Downwind Zone

The Coal Mine Health Inspection Procedures Handbook indicates that persons monitoring a polyurethane spraying application notify workers in the downwind zone. The downwind zone is defined as a distance that is 3 times the air velocity at the application site. During the test with low air flow the downwind zone was calculated to be 60 feet from the application site, and during high air flow, it was calculated to be 750 feet. However, during the period of high air flow, the area HDI monomer and polymer results did not exceed the OEL. So, the calculated reduction in concentration with distance begins with an exposure factor less than 1.

An additional estimation of the downwind zone was calculated based upon the air sampling results and assuming a linear decrease in exposure with increasing distance from the application site. Distances were calculated to estimate the location where the air contaminant concentration would be at the OEL (1), half of the OEL (0.5), and one tenth of the OEL (0.1). These estimates are displayed below.

Ventilation – High Air Velocity (250 ft/min x 3 = 750 feet)

Fraction of OEL	Distance (Feet) IOM – particulate	Distance (feet) HDI monomer and polymer mixture *
1 x OEL	36	---
0.5 x OEL	40	115
0.1 x OEL	42	263

*HDI monomer and polymer mixture did not exceed the OEL during this trial

Ventilation – Low Air Velocity (20 ft/min x 3 = 60 feet)

Fraction of OEL	Distance (Feet) IOM – particulate	Distance (feet) HDI monomer and polymer mixture
1 x OEL	36	25
0.5 x OEL	44	27
0.1 x OEL	50	28

The calculated downwind zone of 60 feet is consistent with the extrapolated distance based upon the air sampling data. However, it is important to note that during high air flow, concentration of HDI polymer may be detectable at exposures up to half the OEL at distances of 115 feet during the time of application but it can be expected that the ventilation over time will reduce the contaminant concentrations more effectively than low air flow.

It is the responsibility of product users to perform their own industrial hygiene sampling and hazard evaluation for their work site conditions.

May 2, 2008
Prodstew\automotive\bedliner\mineapplication\draft4 IH sampling report

Appendix G

Polyurea Retrofit Construction Details

By

C.A Hollerich & E.S. Weiss

The Polyurea retrofit was constructed by: George Watson, Ray Watson, and Josh Bagnell of Micon Mining and George Yakulis, Howard Senkfor, Ed Millero, and Michael Rectenwald of PPG Industries. Jim Addis, Don Sellers, Frank Karnack and Cindy Hollerich of NIOSH assisted with mobilization/demobilization and documentation (May 5 thru May 7, 2008).

- The Micon 550 seal and the PPG Industries' polyurea retrofit system were installed within A-drift of the Lake Lynn Experimental Mine (LLEM). The ribs and roof of the LLEM consists of limestone and the floor consists of 8-in thick reinforced concrete.
- Average dimensions of the Micon 550 seal – 19.6-ft wide x 7.3-ft high (refer to the May 30, 2008 Micon 550 seal construction document for details on that seal).
- To better simulate coal mine floor and rib undulations, attempts were made to scrabble the reinforced concrete mine floor and the concrete abutment on the left inby rib in A-drift using a CP drill with chipper bit.
- Wedges were used under the 1st block course to make level; later these wedges were removed after the Roklok-70 high-density polyurethane foam was applied.
- The Roklok-70 and Seal Lok 120 were heated in the mine (torpedo heater) to 67-68ºF prior to application. The Roklok-70 is a two-component material consisting of Roklok BE-1002 ISO (GMID # 157171; Lot # WC1101BS15) and Roklok (TM) BG-2000 Polyol (GMID# 157679; Batch # WA3001BS08).
- A concrete-block wall (herein referred to as the retrofit block wall) was installed approximately 8-in outby the Micon 550 seal. A total of 151, 8-in by 8-in by 16-in full solid blocks and 28 cut blocks were used (12 courses high with 14-16 blocks per course). The 8-in solid blocks weighed an average of 65.5 lb. Roklok-70 was used on the sides and bottom of each block before setting the block in place. Wood wedges were used at each rib to tighten the block in each course. To fill the gap between the top full block course and the mine roof, wood wedges and 33 half blocks (4-in by 8-in by 16-in solids) and 6 partial blocks were used.
- After the first three full block courses were installed, a shop vacuum was used to remove dust from the floor, ribs, and blocks within this 8-in thick core. The remaining block courses were added as needed as the height of the polyurethane-only core increased.
- Handfuls of gravel were first spread on the concrete mine floor. Then using a hydraulic twin set gear pump, Roklok-70 was injected into the 8-in gap (~95 ft^3 void volume) between the Micon 550 seal and the retrofit block wall to cover the lower portion of the ribs, the first three courses of wall block, the thinly graveled

floor, and under the first course of block as the gaps permitted. The wood wedges used under the first course of block for leveling purposes were then removed after a short period of time (when the Roklok-70 hardened). Roklok-70 continued to be used to coat the ribs and wall blocks as the height of the retrofit block wall increased as the height of the polyurethane-only core increased. A total of approximately 540 lb of Roklok-70 was used during the installation of the retrofit.

- Using a hydraulic twin set gear pump, Seal Lok 120 (approximately 2.5 gals per minute) was injected into the 8-in gap between the Micon 550 seal and the retrofit block wall. Seal Lok 120 is a two-component material consisting of Roklok BE-1000 Isocyanate (GMID # 157169; Lot # WD0301BS09) and Roklok BG-2001 Polyol (GMID # 157680; Lot # WD0301BS10). Approximately 1,150 lb of Seal Lok 120 was used to fill this gap. This calculates to a core density of approximately 12.1 lb/ft^3.
- Construction of the retrofit block wall and 8-in thick polyurethane-only core required approximately 32 worker-hr or 1.5 days to complete.
- The excess Roklok-70 on the outby side of the retrofit block wall was then removed (scraped).
- PPG personnel prepared the outby side of the retrofit block wall surface using duct tape (3M) along the perimeter void spaces and Cord Weatherstrip (caulking) to fill any voids between the blocks and between the blocks and strata.
- Compressed air was then used to remove the dust from the retrofit block wall and the surrounding strata since a layer of dust will adversely affect the adhesion of the polyurea spray coating to the retrofit block wall and strata.
- The polyurea is a two component mixture of Polyoxy Propylene - Mine Seal Wall-Up White (BDL-95617B; Lot # 3720-104) and the Clear Catalyst Hardener (CAT-137; Lot # 08-RAT-100-103) was then sprayed on the retrofit block wall (using a 600cc dual canister spray gun) with an approximately 8- to 12-in overlap to the perimeter strata. The first coat of the spray-applied polyurea required 27 canisters (cartridges) and approximately 45 minutes to complete.
- A second polyurea coating was applied about 45 minutes later. The second coating required 35 canisters (cartridges) and approximately 1 hour to complete. The total thickness of the polyurea (both coatings) was approximately 0.125-0.150 in (3.2-3.8 mm).
- Personal protective equipment (PPE) was required and worn during the polyurea spray application. This PPE consisted of a full face shield, disposable coveralls, gloves, and boots. A NIOSH-approved, positive pressure air-supplied respirator with the required organic vapor and particulate cartridges was worn during all polyurea spray applications and for a short period of time following the applications.
- A fire retardant material (Speedhide Interior Fire Retardant Flat-Latex White 42-7, manufactured by Pittsburgh Paints) was then applied to the polyurea coated retrofit block wall and perimeter strata about an hour after the completion of the second polyurea coating. The fire retardant material was applied with paint brushes and paint rollers. A total of two (2) gallons of fire retardant material was

used and required approximately 45 minutes to complete.

- The mine temperature ranged from 58-59ºF and relative humidity ranged from 96-99% during the retrofit construction period.
- Application of the PPG Industries' polyurea and fire retardant coatings required approximately 22 worker-hr or 0.5 days to complete.
- On May 19th (following LLEM test #523), Ki and Micon personnel installed a 6-in by 6-in by ½-thick steel angle (2, ~9-ft long sections) across the mine floor on the outby side of the PPG retrofit block wall. The steel angle was secured to the mine floor through the use of 1-in diameter by 12-in long Dywidag resin bolts on 12-in centers. All gaps between the steel angle and seal were filled with BlocBond (a high-strength fiber-reinforced surface bonding cement manufactured by Quikrete Co., Atlanta, GA; product # 1225-51).

APPENDIX H

Instructions for LLEM Explosion Tests

*

National Institute for Occupational Safety and Health
Pittsburgh Research Laboratory's
Lake Lynn Laboratory

TITLE: Preparation Instructions for an Explosion in the Lake Lynn Experimental Mine

MINE SHOT PURPOSE: Strengthening existing 20-psi mine seals; evaluation of the PPG retrofit technique in A-drift (designed to generate 50-60 psi at seal).

MINE SHOT DATE: 5/14/08

****SPECIFIC INSTRUCTIONS FOR THIS SHOT****

IGNITION ZONE:

Use ~**10% gas** up to A-50 (695 cubic ft natural gas). Ignite at the face using **triple point ignition**. The electric matches (twist 2 matches together at each of the three locations) are to be equally spaced at mid-height across the closed end face (install back-up shot fire system #2 in the same manner). Use 5 water-filled barrels each at A-25 **and** A-45 as turbulence generators; barrels are equally spaced across the entry at each location.

DUST TEST ZONE:

None.

NOTES:

- Standard-type, 16-in thick solid-concrete-block structures [w/32-in x 16-in center pilaster (flush with main wall on A-drift side) and Type S mortar] are located in crosscuts 1-5 between A- and B-drifts. Each of these structures has been constructed as close as possible to the A-drift ribline. The structure in crosscut 1 has a blast-resistant door located between the center pilaster and the inby crosscut rib. The structures in crosscuts 2 and 3 are to be strengthened by adding 6-in by 6-in by ½-in thick steel angle to the roof and floor on the A-drift side and on the roof on the B-drift side. Additionally, install vertical steel angle from roof to floor (welded to the top and bottom angle) halfway between the center pilaster and each rib for the crosscut 2 and 3 structures on the B-drift side. Fill all gaps between the angle/strata and angle/structure with BlocBond.
- An 20-psi alternative type seal - Micon 550 seal (using 8-in by 8-in by 16-in dry-stacked solid-concrete block walls with a 16-in wide Sealok-120 polyurethane & aggregate core and coated on the inby side) - was installed at A-375 followed by the installation of the PPG retrofit (wall using 8-in solid-concrete-

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blocks with Roclok-70 adhesive between block joints was installed ~8-in outby the Micon 550 seal, the 8-in gap was filled with 10 lb density Sealok-120 polyurethane foam, followed by an ~⅛-in thick spray-applied coating of the polyurea to the outby face of the block wall with a ~2-ft overlap to the floor, roof, and ribs. A fire-resistant latex coating was then applied with paint rollers over the polyurea. The Micon 550 seal was completed on May 5, 2008 and the PPG retrofit was completed on May 7, 2008.

- A 16-in thick wet-laid Omega block stopping with a 48-in by 48-in pilaster is located in crosscut 6; approximately 10-ft into the crosscut. Stopping was completed on April 4, 2008 (40-day cure).
- Crosscut 7 between A- and B-drifts is open.
- Install Viatran transducers at the first three inby locations in A-drift (A-face, A-22, & A-81) to minimize the adverse effect of the flame/temperature on the data.
- Install 200 psi transducers on the steel post just inby of the retrofitted seal across A-drift; one mounted in the horizontal housing and one in the vertical housing. Also, embed a 200 psi transducer so it is nearly flush with the inby side of the seal and located mid-height and close to mid-width (~1-2 ft off center).
- Leave the transducers in place that are installed in crosscuts 6 (and 7 if time permits); mounted horizontally (with the opening facing the explosion) to a 4 in wide steel post which is secured on the roof and floor at the center and as close as possible on the inby side of the crosscut 6 stopping.
- 200 psia transducers were installed within DG panels 4 (A-233), 5 (A-283), and 6 (A-355).
- Calibrate and check all of the transducers; those inby of the PPG retrofitted seal, at the stopping, at the A-face, and in all of the DG panels in A-, B-, and C-drifts. Check the operation of the light sensors within the DG panels.
- Install 2 LVDTs directly to the outby side of the PPG retrofitted seal in A-drift; one located mid-height and mid-width on the seal and the other installed mid-height and ¼ width. Glue the steel backing plates for the LVDT rods onto the PPG polyurea material (do not drill through polyurea).
- Install 1 LVDT indirectly on the B-drift side of the crosscut 6 wet-laid Omega block stopping; mid-height and mid-width. Use fishing line extended from the stopping to the sensor.
- Install both horizontal and vertical breakwires to the outby side of the PPG retrofitted seal in A-drift and to the B-drift side of the crosscut 6 wet-laid Omega block stopping.
- Remove the heat flux gauges adjacent to the DG panels 4 (A-233) and 6 (A-355).
- Install a PRL probe (bi-direction pressure sensor) from the center of the mine roof at the instrument platform located near A-355 inby the PPG retrofitted seal in A-drift.
- Spray paint the inby seal/strata perimeter of the Micon 550 seal across A-drift as a means to more readily determine any seal movement.
- After turning off the air compressor and releasing the pressure, partially open all of the compressed air valves inby the PPG retrofitted seal in A-drift as a means to dilute the methane (in the event of misfire or an abort situation) or the post-explosion CO levels.
- Remove the caps from the water drainage pipes at the base of the block structures in crosscuts 1-3 prior to leaving the mine to conduct the shot (will facilitate the post-explosion ventilation). These caps must be kept on during air-leakage tests.

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∋ Collect the NI-PC data at 1,500 Hz (15 pt smoothing) for 5 sec and the KS-CAMAC at 5,000 Hz (51 pt smoothing) for ~11 sec.

∋ Collect 2 gas samples from the roof sampling port near the diaphragm of the A-drift methane zone.

∋ **AFTER SHOT, OPEN THE VENT SHAFT DOOR AND TURN ON THE MINE FAN TO SPEED 1 (ONE) BLOWING. EXERCISE EXTREME CAUTION WHEN RE-ENTERING THE MINE; USE TWO HAND-HELD DETECTORS WHEN RE-ENTERING THE MINE; RE-ENTER THROUGH D-E DRIFTS; DO NOT CONTINUE INBY IF THE CO LEVELS EXCEED SAFE & ACCEPTABLE LEVELS. OPEN THE BULKHEAD DOOR AND THEN PROCEED TOWARD A-DRIFT. RE-INSTALL THE BRATTICE CURTAINS TO THE AIR-LEAKAGE FRAMEWORKS LOCATED JUST OUTBY CROSSCUT 1 IN C- AND B-DRIFTS TO DIRECT MORE VENTILATION TO A-DRIFT. OPEN THE CROSSCUT 1 BLAST DOOR BETWEEN A-B DRIFTS AND EXIT THE MINE VIA D-DRIFT. ONCE OUTSIDE, PUT MINE FAN ON SPEED 4 (FOUR) BLOWING AND TURN ON GAS ZONE MIXING FAN. AT END OF DAY, TURN OFF MIXING FAN AND COMPRESSOR AND PUT MINE FAN ON SPEED 2 (TWO) BLOWING FOR OVERNIGHT.**

STANDARD SAFETY

FOLLOW SOP FOR DUST/GAS TESTS IN A-DRIFT

CLOSE D DRIFT BULKHEAD DOOR EXCEPT FOR A 3 FT OPENING. CLOSE C DRIFT BULKHEAD DOOR, BUTTERFLY VALVE, AND ALL SUBMARINE DOORS AND INFLATE GASKETS. WEDGE DOOR FROM E DRIFT SIDE.

FROM SHOTFIRE #3, INSTALL A JOULE IGNITOR ON THE A DRIFT GAS ZONE DIAPHRAGM AS A MEANS TO RUPTURE DIAPHRAGM IN EVENT OF SHOTFIRE MISFIRE.

LEAVE THE FAN ON AND WEAR/HAVE APPROPRIATE PERSONAL PROTECTIVE GEAR WHEN HANDLING DUST AND/OR DURING POST-EXPLOSION RE-ENTRY AND CLEANUP.

Please make special note that the POST SHOT OPERATIONS of the LAKE LYNN CHECK LIST calls for the mine fan to be operated on the forward high-speed setting after opening the butterfly valve on the bulkhead door. Following an explosion, the use of a personal carbon monoxide monitor (and each person carrying a W-65 with at least one SR-100 in group) is mandatory to provide additional detection and protection measures to reduce the chance of exposure to carbon monoxide. **Do not enter any areas, without first ventilating. Do not enter any areas where the carbon monoxide levels exceed safe levels.**

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TITLE: Preparation Instructions for an Explosion in the Lake Lynn Experimental Mine

MINE SHOT PURPOSE: Strengthening existing 20-psi mine seals; evaluation of the PPG retrofit technique in A-drift (designed to generate 75-80 psi at seal).

MINE SHOT DATE: 5/21/08

****SPECIFIC INSTRUCTIONS FOR THIS SHOT****

IGNITION ZONE:

Use ~**10% gas** up to A-85 (1,100 cubic ft natural gas). Ignite at **A-20** using **triple point ignition**. The electric matches (twist 2 matches together at each of the three locations) are to be **equally spaced about 1-ft off the floor at A-20** (install back-up shot fire system #2 in the same manner). Use 5 water-filled barrels each at A-25 **and** A-45 as turbulence generators; barrels are equally spaced across the entry at each location.

DUST TEST ZONE: None.

NOTES:

- Standard-type, 16-in thick solid-concrete-block structures [w/32-in x 16-in center pilaster (flush with main wall on A-drift side) and Type S mortar] are located in crosscuts 1-5 between A- and B-drifts. Each of these structures has been constructed as close as possible to the A-drift ribline. The structure in crosscut 1 has a blast-resistant door located between the center pilaster and the inby crosscut rib. The structures in crosscuts 2 and 3 are to be strengthened by adding 6-in by 6-in by ½-in thick steel angle to the roof and floor on the A-drift side and on the roof on the B-drift side. Additionally, install vertical steel angle from roof to floor (welded to the top and bottom angle) halfway between the center pilaster and each rib for the crosscut 2 and 3 structures on the B-drift side. Fill all gaps between the angle/strata and angle/structure with BlocBond.
- An 20-psi alternative type seal - Micon 550 seal (using 8-in by 8-in by 16-in dry-stacked solid-concrete block walls with a 16-in wide Sealok-120 polyurethane & aggregate core and coated on the inby side) - was installed at A-375 followed by the installation of the PPG retrofit (wall using 8-in solid-concrete-blocks with Roclok-70 adhesive between block joints was installed ~8-in outby the Micon 550 seal, the 8-in gap was filled with 10 lb density Sealok-120 polyurethane foam, followed by an ~⅛-in thick spray-

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applied coating of the polyurea to the outby face of the block wall with a ~2-ft overlap to the floor, roof, and ribs. A fire-resistant latex coating was then applied with paint rollers over the polyurea. The Micon 550 seal was completed on May 5, 2008 and the PPG retrofit was completed on May 7, 2008. On May 19th, 6-in by 6-in by ½-in thick steel angle (2, ~9-ft long sections) was anchored by Micon/Ki on the outby floor of the PPG retrofit using 1-in diameter by 12-in long threaded rebar (75,000 psi) embedded and glued (resin) 9-in into floor.

- A 16-in thick wet-laid Omega block stopping with a 48-in by 48-in pilaster is located in crosscut 6; approximately 10-ft into the crosscut. Stopping was completed on April 4, 2008 (40-day cure).
- Crosscut 7 between A- and B-drifts is open.
- Install a second mixing fan within the A-85 gas zone to facilitate the mixing of the natural gas.
- Install Viatran transducers at the first three inby locations in A-drift (A-face, A-22, & A-81) to minimize the adverse effect of the flame/temperature on the data.
- Install 200 psi transducers on the steel post just inby of the retrofitted seal across A-drift; one mounted in the horizontal housing and one in the vertical housing. Also, embed a 200 psi transducer so it is nearly flush with the inby side of the seal and located mid-height and close to mid-width (~1-2 ft off center).
- Leave the transducers in place that are installed in crosscuts 6 (and 7 if time permits); mounted horizontally (with the opening facing the explosion) to a 4 in wide steel post which is secured on the roof and floor at the center and as close as possible on the inby side of the crosscut 6 stopping.
- 200 psia transducers were installed within DG panels 4 (A-233), 5 (A-283), and 6 (A-355).
- Calibrate and check all of the transducers; those inby of the PPG retrofitted seal, at the stopping, at the A-face, and in all of the DG panels in A-, B-, and C-drifts. Check the operation of the light sensors within the DG panels.
- Install 2 LVDTs directly to the outby side of the PPG retrofitted seal in A-drift; one located mid-height and mid-width on the seal and the other installed mid-height and ¼ width. Re-glue the steel backing plate to the middle of the seal and then re-glue the middle LVDT rod to the plate (since the steel plate decoupled during test #523) and re-glue the ¼-width LVDT rod back onto the steel backing plate (do not drill through polyurea).
- Install 1 LVDT indirectly on the B-drift side of the crosscut 6 wet-laid Omega block stopping; mid-height and mid-width. Use fishing line extended from the stopping to the sensor.
- Document the pre- and post-test LVDT voltage readings and note if LVDTs were re-zeroed.
- Install both horizontal and vertical breakwires to the outby side of the PPG retrofitted seal in A-drift and to the B-drift side of the crosscut 6 wet-laid Omega block stopping.
- Install a PRL probe (bi-direction pressure sensor) from the center of the mine roof at the instrument platform located near A-355 inby the PPG retrofitted seal in A-drift.
- Spray paint (other than the yellow-green used during the first test) the inby seal/strata perimeter of the Micon 550 seal across A-drift as a means to more readily determine any seal movement.
- After turning off the air compressor and releasing the pressure, partially open all of the compressed air valves inby the PPG retrofitted seal in A-drift as a means to dilute the methane (in the event of misfire or

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an abort situation) or the post-explosion CO levels.

- Remove the caps from the ¾-in diameter instrument conduits at the top of the block structures in crosscuts 2-3 prior to leaving the mine to conduct the shot (will facilitate the post-explosion ventilation); Install the 2-in diameter caps back onto the drainage pipes near the floor for the block structures in crosscuts 1-3. All of the caps must be kept on during air-leakage tests.
- Collect the NI-PC data at 1,500 Hz (15 pt smoothing) for 5 sec and the KS-CAMAC at 5,000 Hz (51 pt smoothing) for ~11 sec.
- Collect 2 gas samples from the roof sampling port near the diaphragm of the A-drift methane zone.
- **AFTER SHOT, OPEN THE VENT SHAFT DOOR AND TURN ON THE MINE FAN TO SPEED 1 (ONE) BLOWING. EXERCISE EXTREME CAUTION WHEN RE-ENTERING THE MINE; USE TWO HAND-HELD DETECTORS WHEN RE-ENTERING THE MINE; RE-ENTER THROUGH D-E DRIFTS; DO NOT CONTINUE INBY IF THE CO LEVELS EXCEED SAFE & ACCEPTABLE LEVELS. OPEN THE BULKHEAD DOOR AND THEN PROCEED TOWARD A-DRIFT. RE-INSTALL THE BRATTICE CURTAINS TO THE AIR-LEAKAGE FRAMEWORKS LOCATED JUST OUTBY CROSSCUT 1 IN C- AND B-DRIFTS TO DIRECT MORE VENTILATION TO A-DRIFT. OPEN THE CROSSCUT 1 BLAST DOOR BETWEEN A-B DRIFTS AND EXIT THE MINE VIA D-DRIFT. ONCE OUTSIDE, PUT MINE FAN ON SPEED 4 (FOUR) BLOWING AND TURN ON GAS ZONE MIXING FAN. AT END OF DAY, TURN OFF MIXING FAN AND COMPRESSOR AND PUT MINE FAN ON SPEED 2 (TWO) BLOWING FOR OVERNIGHT.**

STANDARD SAFETY

- FOLLOW SOP FOR DUST/GAS TESTS IN A-DRIFT

- CLOSE D DRIFT BULKHEAD DOOR EXCEPT FOR A 3 FT OPENING. CLOSE C DRIFT BULKHEAD DOOR, BUTTERFLY VALVE, AND ALL SUBMARINE DOORS AND INFLATE GASKETS. WEDGE DOOR FROM E DRIFT SIDE.

- FROM SHOTFIRE #3, INSTALL A JOULE IGNITOR ON THE A DRIFT GAS ZONE DIAPHRAGM AS A MEANS TO RUPTURE DIAPHRAGM IN EVENT OF SHOTFIRE MISFIRE.

- LEAVE THE FAN ON AND WEAR/HAVE APPROPRIATE PERSONAL PROTECTIVE GEAR WHEN HANDLING DUST AND/OR DURING POST-EXPLOSION RE-ENTRY AND CLEANUP.

Please make special note that the POST SHOT OPERATIONS of the LAKE LYNN CHECK LIST calls for the mine fan to be operated on the forward high-speed setting after opening the butterfly valve on the bulkhead door. Following an explosion, the use of a personal carbon monoxide monitor (and each person carrying a W-65 with at least one SR-100 in group) is mandatory to provide additional detection and protection measures to reduce the chance of exposure to carbon monoxide. **Do not enter any areas, without first ventilating. Do not enter any areas where the carbon monoxide levels exceed safe levels.**

APPENDIX I
Pressure Data from LLEM Explosion Tests

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Table H1. Maximum wall and seal pressures using Kinetic System data acquisition system during test 1 (LLEM Test #523)

Wall Pressures in A-Drift			
Location	**Distance Feet**	**Pressure (Smoothed) PSI**	**Pressure (Actual) PSI**
A-Drift	22	23.4	25.12
A-Drift	81	23.39	26.18
A-Drift	132	26.29	28.72
A-Drift	183	23.82	25.28
A-Drift	233	27.65	29.16
A-Drift	283	33.51	37.48
A-Drift	355	44.55	48.13
A-Drift	453	0.71	1.14
A-Drift	440	0.69	0.69
A-Drift	649	0.69	0.69
A-Drift	807	0.72	0.72
Seal Pressures in A-Drift			
Location	**Distance Feet**	**Pressure (Smoothed) PSI**	**Pressure (Actual) PSI**
Crosscut 3	305	40.01	40.01
Retrofit Test Seal	375	60.58	78.51

Data Collected with Kinetic Systems, Inc. data acquisition system
Sampling rate of 5000 samples per second
Smoothed data has been averaged over 51 points.

Table H2. Maximum wall and seal pressures using National Instruments Corp. data acquisition system during test 1 (LLEM Test #523)

Wall Pressures in A-Drift			
Location	Distance Feet	Pressure (Smoothed) PSI	Pressure (Actual) PSI
A-Drift	22	23.52	25.13
A-Drift	81	23.55	26.2
A-Drift	132	26.55	30.47
A-Drift	183	23.97	25.63
A-Drift	233	28.09	29.66
A-Drift	283	34.11	38.06
A-Drift	355	44.9	49.38
A-Drift	453	0.42	1.23
A-Drift	440	0.09	0.21
A-Drift	649	0.14	0.28
A-Drift	807	0.11	0.25
Seal Pressures in A-Drift			
Location	**Distance Feet**	**Pressure (Smoothed) PSI**	**Pressure (Actual) PSI**
Crosscut 3	305	33.69	38.03
Retrofit Test Seal	375	60.39	69.63

Data Collected with National Instruments Corp data acquisition system
Sampling rate of 1500 samples per second
Smoothed data has been averaged over 15 points.

Table H3. Maximum wall and seal pressures using Kinetic System data acquisition system during test 2 (LLEM Test #524)

Wall Pressures in A-Drift			
Location	Distance Feet	Pressure (Smoothed) PSI	Pressure (Actual) PSI
A-Drift	22	36.02	49.2
A-Drift	81	31.07	32.43
A-Drift	132	28.04	33.34
A-Drift	183	26.74	30.4
A-Drift	233	30.37	32.91
A-Drift	283	35.4	38.56
A-Drift	355	60.74	70.48
A-Drift	453	0.67	0.67
A-Drift	440	0.67	0.67
A-Drift	649	0.67	0.68
A-Drift	807	0.72	0.72
Seal Pressures in A-Drift			
Location	**Distance Feet**	**Pressure (Smoothed) PSI**	**Pressure (Actual) PSI**
Crosscut 3	305	36.27	40
Retrofit Test Seal	375	70.03	84.43

Data Collected with Kinetic Systems, Inc. data acquisition system
Sampling rate of 5000 samples per second
Smoothed data has been averaged over 51 points.

Table H4. Maximum wall and seal pressures using National Instruments Corp. data acquisition system during test 2 (LLEM Test #524)

Wall Pressures in A-Drift			
Location	Distance Feet	Pressure (Smoothed) PSI	Pressure (Actual) PSI
A-Drift	22	37.01	49.5
A-Drift	81	31.92	32.39
A-Drift	132	30.62	33.42
A-Drift	183	27.61	30.45
A-Drift	233	31.25	33.14
A-Drift	283	37.9	38.45
A-Drift	355	67.59	70.72
A-Drift	453	0.14	0.45
A-Drift	440	0.14	0.45
A-Drift	649	0.09	0.38
A-Drift	807	0.14	0.35
Seal Pressures in A-Drift			
Location	**Distance Feet**	**Pressure (Smoothed) PSI**	**Pressure (Actual) PSI**
Crosscut 3	305	37.44	38.51
Retrofit Test Seal	375	73.41	84.62

Data Collected with National Instruments Corp data acquisition system
Sampling rate of 1500 samples per second
Smoothed data has been averaged over 15 points.