MSHA Approval Number: 120M – 15.1

120 PSI Main Line J-SEAL® *
JENNCHEM, LLC.

SUMMARY OF INSTALLATION GUIDELINES

A. Material Requirements:

1. J-Seal is a pre-blended cementitious non-flammable powder packaged in 45-lb, 3-ply, and one layer polyethylene bags. Prior to bagging off each batch, QC tests are conducted to check gel time, foam stability, and density. Any batch not passing QC specifications will be quarantined for strength testing. If the sample does not pass the tests then the corresponding batch will be quarantined and red tagged. The J-Seal bags are typically palleted as a pack. The entire pallet is covered with an impermeable plastic wrap or "raincoat". Such packaging enables temporary outside storage under most conditions. However, the material must not be stored directly on the ground in areas with standing water.

2. Prior to mixing, J-Seal bags shall be examined for elapsed shelf life and any damage that may have occurred during the material handling process. In case the bags are broken, the hardened material shall be discarded. J-Seal has a shelf life of three months. A "use by" date of each batch is clearly indicated on each corresponding factory wrapped pallet. Any pallet still factory wrapped not containing this "use by" marking, shall be rejected. Beyond this period, standard J-Seal QC tests (compressive strength that correlates to the fully cured strength) should be conducted on expired material to determine if it still passes all the tests. Jennchem may grant and document shelf life extensions for 30 days beyond the "use by" date only if the results of the QC tests are acceptable.

3. At no time may any additional mixtures be added into the product. No aggregates or chemical additives should be added to the J-Seal material prior to mixing, during mixing, or during placement in the seal forms.

4. The existing mine water supply of at least 25 gpm at 50 psi is sufficient for the mixing of the J-Seal material. The acceptable water temperature range at the mixer shall be 55 - 75 ^{o}F. Prior to the initiation of a seal project at a mine, the water source will be evaluated by Jennchem to ensure its compatibility with J-Seal material. If there are any changes noted in the quality or source of the water, it will be re-evaluated with the prescribed tests. The test will not identify chemical substances in the water. Standard quality control samples will be prepared with the questionable sample water to check if the J-Seal

grout will achieve a minimum of 410 psi within specified period. The water check results shall be documented by Jennchem. If the strength meets the requirements, the mine water can be used as it is. Otherwise, a new water source shall be utilized.

5. Only a placer approved by Jennchem may be used to place J-Seal grout into a Jennchem 120 psi main line seal.

B. <u>Site Preparation:</u>

1. The J-Seal must be constructed in a stable entry opening with a minimum strata shear strength of 92 psi. All strata surrounding the proposed seal shall be evaluated and meet or exceed the shear strength requirement. The certifying Professional Engineer (PE) may evaluate the strata shear strength using existing rock mechanics data or relevant field test data. The seal must not be located where a geologic feature, such as a fault or open joint, would compromise the performance of the seal. Pillar stability shall be confirmed either by reference (i.e. Approved Roof Control Plan, ARMPS, prior analysis, etc.) or evaluation by the certifying PE before the seal installation. If multiple seam mining is present, the certifying PE will confirm that any additional stress will not be detrimental to the seal. Such information shall be included in the seal location certification that is to be provided to the MSHA district office.

2. Entry width at the inby and outby faces should be approximately consistent with a tolerance of ± 5%. The entry width shall not be tapered from either inby or outby direction. If necessary, excavation shall be made around the perimeter to insure that the in-contact rib faces are approximately parallel.

3. To minimize air leakage, the seal shall not be located less than 5’ from the corner of any pillar. If the seal has to be located less than 10’ from the corner of the pillar, permission from the MSHA District office is necessary. The ribs shall be reinforced with means approved by the governing District. This shall be done prior to seal installation if the short dimension is inby the seal.

4. Rock dust should be removed from the strata within the seal form by compressed air, pressurized water, or mechanical means. Surfaces upon which J-Seal is to be placed must be free from debris, oil, and unsound material.

5. The seal shall be placed against competent strata. If the surrounding strata is fractured, weak or soft, or may become weaker or softer from exposure to water, the strata must be scaled down to competent strata prior to placement of the seal.

   As an alternative, to maintain original opening height, the thick weak floor material may be excavated down to competent strata and a base may be

constructed in the excavated area with high strength grout, quick set concrete, or similar material to the approximate floor level. The seal can be constructed on the new base under the direction of the Professional Engineer (PE) or the designee.

The base construction material must have an unconfined compressive strength (UCS) equal to or greater than 1,000 psi. A minimum of nine (9) samples shall be taken from the floor material. Three (3) shall be taken when the floor cavity is approximately 1/3 full, three (3) more samples taken when the cavity is approximately 2/3 full, and the final three (3) samples when the cavity is nearly filled to the mine floor horizon. The samples must be taken in a completely random manner into appropriate cylindrical containers with lid. The samples will be tested to determine the UCS. The average minimum UCS of the material samples must be 1,000 psi with not more than two (2) samples testing below 1,000 psi, and no samples testing below 750 psi.

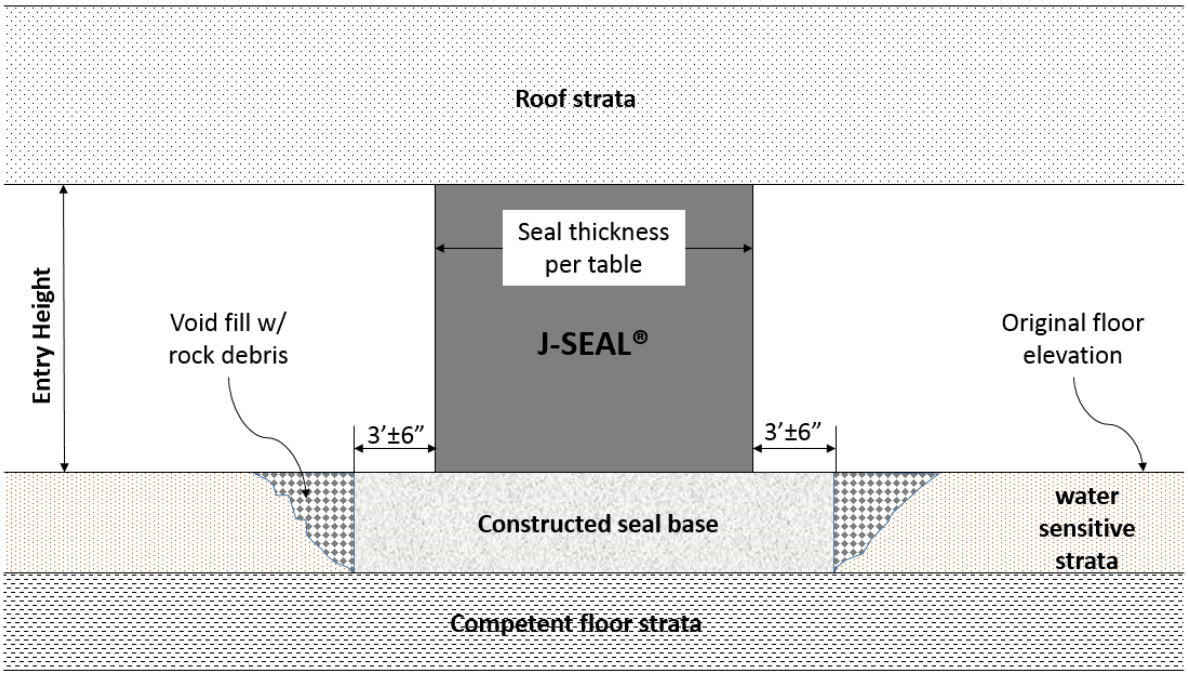
Each of the samples must be taken directly from the material discharge point as it is placed into the floor excavation. Each sample must be filled to the top of an appropriate cylindrical container. Sample containers shall be tapped and/or stirred to insure that no large air pockets were entrapped during the sampling process. Any excess material will be scraped off the top of the container before the lid is attached. Each sample container will be marked with a permanent marker identifying the date, seal location, and location in the floor cavity where the sample was taken. The samples are to remain in the mine to cure under approximately the same conditions as the material poured into the floor cavity. If the design strength is required at an earlier curing time, additional samples may be taken following the sampling procedure.

The top surface of the material poured into the floor shall be covered with plastic sheeting, brattice material, or material specified in ASTM C 171, to prevent moisture loss during curing. The top surface of the material poured into the floor shall not be smooth, but as rough as practically possible. Surface roughness shall not be less than 1 inch per 4 feet. This can be checked by placing a four (4) foot straight edge against the top surface of the base and measuring the surface variation perpendicular to the edge. Surfaces smoother than this requirement must be mechanically roughened, at the direction of the PE or the designee prior to seal installation. Seal installation cannot begin on the constructed base until the material reaches the average minimum required UCS as determined by sample testing.

If the top surface or the newly poured base is higher than the approximate inby floor horizon, then the bottom of any drainage pipe on the inby side must be no less than 4 inches above the top surface of the base, and no more than 12 inches above the original mine floor horizon. If the top surface of the base is lower than the approximate original inby floor horizon, then the bottom of any drainage pipe on the inby side must be no less than 4 inches above the top

surface of the base, and no more than 12 inches above the original mine floor horizon.

Surfaces upon which the new base is to be poured can be damp but must be completely free of running or standing water. All debris, oil, or any unsound material must be removed. Flowing water shall be diverted or pumped away from the seal site. The area excavated for the base construction must have a bottom minimum dimension of 3' ± 6" greater than the width of the proposed seal on both the inby and outby sides. Refer to the figure below for a typical base design.



While constructing the base, the excavated cavity can be filled entirely with high strength grout, or similar material. Normal formwork can also be used for construction of the base. The formwork can remain in place or be removed once the base has achieved the minimum UCS per the sampling procedure. The excavated area can be backfilled with dirt and/or rock debris to the approximate original floor horizon.

6. All loose material must be removed from the seal location and for a distance of 3' ± 6" on each side of the seal.

7. Good housekeeping practices shall be observed, such as removing any debris within 50' of the area being sealed.

8. All metal objects passing through the seal location, such as roof mesh, straps, rails, pipes, and wires, must be removed before any seal site preparation can begin. Any active or inactive pipelines, cables, either metallic or non-metallic,

shall be relocated and/or rerouted to allow proper site preparation. If these objects cannot be removed safely, another seal location must be selected.

9. The strata at the seal perimeter shall be as rough as practically possible and smooth surfaces shall be avoided prior to J-Seal placement. Surface roughness shall not be less than 1" per 4'. This can be established by placing a 4' long straight edge against the strata and measuring the surface variation perpendicular to the edge. Surfaces smoother than this requirement must be mechanically roughened at the direction of the certifying PE or the designee, prior to the seal installation.

10. Excluding normal mine rib and floor dampness, the area must be free of standing and running water. All debris, oil, and unsound material must be removed at the direction of the certifying PE or the designee prior to the seal installation. Excessive standing or flowing water will be pumped or diverted away from the seal sites. If the water flows through the strata into the seal location, another location will be selected.

11. Prior to seal installation, drainage pipe valves in any existing mine seals inby the new seal must be set in the open position and the u-trap removed. Also, immediately prior to seal placement, stoppings in the first crosscut inby the new seal must be breached or removed.

C. <u>Determination of Minimum Seal Thickness:</u>

1. Depending on the type of seal wall that the mine prefers to, each pair of forms shall be constructed to ensure the minimum thickness of the J-Seal, as indicated either in Appendix Q-1, "Thickness Specification - Installation Table - Kennedy or Concrete Block Forms - 120 psi Main Line Seal" or in Appendix Q-2, "Thickness Specification - Installation Table - Forms with Wood and Brattice, or Forms with RIP Props, Welded Wire Mesh and Brattice - 120 psi Main Line Seal".

2. The minimum seal thickness is determined based on the maximum height (including voids and/or "pot outs" in the roof) and maximum width that occurs within the seal location after loose strata has been removed. When the maximum opening height or width is between values on the appropriate design table, the next larger thickness shall be used.

3. The forms can be constructed to any thickness, as long as it meets the minimum required thickness outlined in the tables.

D. <u>Form Sequence Guidelines – Wood & Brattice Forms:</u>

1. For wood and brattice seal walls, vertical site-specific posts and/or cribs (wood, pumpable or equivalent) shall be used. Posts should be nominally 4" x 4" or

larger and shall be installed in each wall on typical centers of 30” ± 6”. Cribs or equivalent pumpable cribs, shall be installed both inby and outby within 5’ from the wall, and complying with the approved mine ventilation plan. All supplemental standing support shall comply with the approved roof control plan.

2. Horizontal wood boards (minimally 1” x 6” ± 2”) will be attached to the inner face of the posts or cribs on no more than 18” centers.

3. A brattice cloth shall be hung over the interior of the formwork, leaving no more than a 3” ± 1” overlap on the roof, rib, and floor. The brattice cloth overlap must be kept to a minimum, in order to maximize contact of the J-Seal with the strata. The brattice cloth and framing shall be maintained in place for the duration of the seal life. In the event the brattice cloth is damaged to the extent that the J-Seal material is visible, it will be the responsibility of the operator to repair the damaged cloth.

E. <u>Form Sequence Guidelines – Forms with RIP Steel Prop, Welded Wire Mesh and Brattice:</u>

1. For seal walls constructed with the RIP steel prop, welded wire or plastic mesh, and brattice cloth, vertical site specific posts and/or cribs are not required. The Jennmar RIP 50 steel prop or equivalent prop that has a minimum of 14” height adjustability and a minimum of 50 tons of support capacity shall be used. For each seal wall, one row of props shall be erected at a space no less than 5’ apart with two side props positioned as close to coal rib as practical. Any loose material above and underneath the prop shall be scaled down to solid strata. The screw top of the RIP 50 shall be raised up to tightly contact the roof strata. Prior to hanging the mesh and brattice cloth, all the props should be checked to insure that props will resist lateral movement. Props are not to be removed after seal installation.

2. Wire mesh or similar plastic mesh will be tied vertically to the props along the interior seal walls. In case multiple sheets are used to cover the entire seal wall, a minimum of 6” overlapping should be maintained between adjacent mesh sheets. Edges of the mesh shall be profiled to fit the contours of the roof, ribs, and floor as close as possible. If wire mesh is used, to avoid a continuous metal contact path between the inby and outby faces, the operator will insure that the mesh on the outby formwork will not contact the same on the inby formwork any place along the seal perimeter.

3. A brattice cloth shall be hung over the interior of the formwork, leaving no more than a 3” ± 1” overlap on the roof, rib, and floor. In order to maximize contact of the J-Seal with the strata, the brattice cloth overlap must be kept to a minimum. The brattice cloth and prop-mesh framing shall be maintained in place for the duration of the seal life. In the event the brattice cloth is

damaged to the extent that the J-Seal material is visible, it will be the responsibility of the operator to repair the damaged cloth.

F. <u>Form Sequence Guidelines – Concrete Masonry Unit Forms:</u>

1. Standard Concrete Masonry Unit (CMU) blocks (nominally 4” x 8” x 16”) or equivalent shall be used to construct two seal walls.

2. The CMU blocks will be dry stacked to form nominally 4” thick parallel walls.

3. Each wall will be secured in place using wooden wedges. The wedges will be installed to avoid as much possible extending inside the form (i.e., wedges will be driven near parallel to the wall).

4. An access hole will be left in the outby wall to allow access to facilitate placement of J-Seal inside the forms during the construction process. These holes will be blocked during the filling process.

5. With the exception of seals affected by the final ventilation change, all outside walls will be coated with B-bond or equivalent sealant. The last seal will be coated on the inby side as much as possible while still providing egress to the seal space.

G. <u>Form Sequence Guidelines – “Kennedy” Type Stopping Forms:</u>

1. For “Kennedy” forms, install horizontal rails no more than 24 inches apart or away from the floor and roof.

2. Install panels on rails, again insuring the seal’s interior thickness meets or exceeds the minimum thickness requirement. The “ribs” of the “Kennedy” forms will be facing out from the interior of the seal.

3. Leave the desired number of Kennedy panels lowered from the roof to be used as an opening for filling the seal.

4. Standing support shall be installed to brace the outside of the inby and outby form walls. In addition, form ties can be used as long as they are non-conductive.

H. <u>Other Seal Wall Components:</u>

1. The front/outby wall shall have one or more temporary hatches that will allow access to the inside of the forms during the construction process. Once the grout is filled up close to the hatch, the hole shall be covered properly to ensure that no grout will flow out.

2. A minimum of three (3) pressurization fill pipes, 1¼-inch diameter PVC, shall

be inserted through all formworks. The first will be located in the center of the seal ± 2' and as close as possible to the roof. The two (2) remaining fill pipes shall be placed 3' ± 1' from each rib and as close to the roof as possible. Any seal that exceeds 10' in thickness shall have a minimum of six (6) pressurization fill pipes in two rows of three. Each row will terminate 2/3 ± 1' and 1/3 ± 1' of the thickness from the outby wall.

3. Bleeder pipes (1¼" or larger PVC) shall be inserted through the formwork between the fill pipes. In order for the bleeder pipe to confirm complete filling of the voids, the bleeder pipes should be inserted approximately halfway into the seal thickness, and their inby ends should be raised or tilted to approach the highest roof, particularly in a high area or uneven roof with undulation greater than 2'. The bleeder pipes shall be plugged with rags (or similar material) after material flow is evident and prior to final pressurization.

4. An approved foam pack or equivalent can be used around the perimeter of all formworks and pipe annular openings to minimize leakage during the material pressurization. Foam may not be applied to the inside of the CMU or Kennedy type forms. Foam cannot extend beyond the 3" interior brattice overlap on wooden forms.

5. As an option, if the surrounding strata has discontinuity features that may pose gas or water egress, the Jennchem pre-drill, post concrete placement ring grouting plan may be implemented. Grout holes drilled into adjacent strata within the body of the plug seal shall be injected post concrete placement via Jennchem Non-Conductive Grout Tubes (NCGT). NCGT (3/4" diameter or similar) shall exit the seal from ports in the formwork. The size of a group shall not exceed 8" in diameter and placement of the groups must not be less than 16" edge to edge with rib, roof, or other seal drainage or inertion pipes. Each NCGT will be marked with their location in the strata. The grout shall be injected after the concrete UCS meets minimum seal strength specifications.

   Post J-Seal installation ring grouting shall be conducted only by Jennchem personnel, or Jennchem authorized personnel using Jennchem approved materials and methods.

I. <u>Water Drainage System:</u>

1. A water drainage system shall be installed during seal construction in the lowest elevation seal(s) of the set. This seal is not designed to impound water, other than to a minimal, unavoidable depth (maximum 12" from bottom of the inby drainage pipe to floor). Pipe sizes will range between 4" and 8" inside diameter. The pipes used must be non-metallic and corrosion resistant and shall have an internal pressure rating of at least 240 psi. The distance between the rib and closest drainage pipe wall shall not be less than 3' from the rib to the edge of the pipe. If more than one drainage pipe is

installed in the seal, the horizontal distance between the pipes must not be less than 3' edge to edge. The maximum number and size of pipes must be determined by the certifying PE based on the entry width, rib-pipe distance, pipe-pipe distance, and projected inflows and outflows. The number of drainage pipe cannot exceed 5 per seal.

2. Pipes must be installed as low as practical, to minimize the depth of water against the inby side of the seal. A minimum of 4" will be maintained between the bottom of the pipe and floor inby and outby the water trap. The actual height of the pipe in the seal will depend on the gradient of the floor. The pipe will be set so that it is declining or level to allow for gravity drainage of water from inby the seal. The bottom of the inby side of the drainage pipe will be no more than 12" off the mine floor.

3. Pipe sections must be joined in accordance with the pipe manufacturer's installation recommendations. Pipe joints and couplers must have a resistance to an internal pressure of at least 240 psi.

4. The drainage system must be equipped to prevent the exchange of air through the pipe(s). A water trap and valve will be installed on the outby side of each drainage pipe. The pipe, valve, joints, couplers, and water trap must have a blast resistance equivalent to at least 240 psi. The valve must be installed on the inby side of the water trap. Water traps must be u-shaped with inspection and clean-out cap, and the vertical depth of the u-portion of the trap must be large enough that a sufficient quantity of water can be maintained in the trap to prevent evaporation prior to the scheduled periodic examination. The u-portion of the water trap shall be recessed into the mine floor, and the recessed area shall be filled in with cement.

5. If required by the governing District, a water height measuring system shall be installed that consists of a sight tube, and two horizontal 1" inside diameter non-metallic, nonconductive pipes installed through the seal. One pipe shall be securely installed through the seal at the approximate height of the top of the water trap and the other pipe shall be securely installed through the seal close to the roof. The distance from the upper pipe to the mine roof and the distance from the lower pipe to the mine floor shall be at the discretion of the governing District. On the outby side of each pipe, a shut-off valve shall be installed. Each shut-off valve and pipe extending through the seal must have an internal pressure rating of 240 psi. Two, 90-degree elbows shall be installed on the outby end of each pipe after the valves are in place. A clear plastic tube shall be securely placed between these elbows for viewing of the water elevation.

6. If a new seal is to be placed on the outby side of an existing seal, the new water drainage pipes shall be connected to corresponding water drainage pipes in the inby existing seal. Prior to seal installation, valves of the water

drainage pipes in the existing mine seal must be set in the open position and u-trap removed.

7. To trap sediment and debris that may clog the drainage pipe(s), a weir shall be constructed across the entry inby for all seals installed with drainage pipes. The weir shall be constructed either of concrete or cement block with the top of the weir level with bottom of the invert pipe. A screen shall be installed behind the weir to the height twice that of the weir.

8. J-Seal water drainage pipes during seal construction, may be used for the temporary routing of water. However, these pipes are to be properly connected (i.e. water tight with no leakage) to the water drainage pipe(s) before pouring of J-Seal grout commences. If water is leaking or flowing from these connections, pouring of J-Seal grout cannot be conducted. The temporary connections shall be disconnected before the final seal is installed.

9. No water shall ever be allowed to accumulate against the outby side of the J-Seal.

J. <u>Gas Monitoring System:</u>

1. Each newly constructed seal shall have one (1) non-metallic sampling tube, extending one-half of the expected open space inby the seal, as described in 30 CFR §75.337(g)(1). The diameter and material for the sampling pipe will be submitted to the MSHA District Manager by the mine operator in the Mine Ventilation Plan, and it will be between ¼" and 1" diameter, with a pressure rating of 240 psi for all the components (valves, connections, fittings, and pipes). The inby end of the sampling tube will be placed not more than 18" from the roof.

2. If the new seal is placed on the outby side of an existing seal, non-metallic gas sampling pipes, rated at 240 psi blast pressure, shall be connected to each sampling pipe in each seal. The new gas sampling pipe will have a new 240 psi shutoff valve installed outby the seal. If there is any space between the new and existing seal, that area will also be provided with a sampling pipe of the same specifications.

3. Pipe(s) may be installed during seal construction for injecting an inert gas into the sealed mine area. Pipe sizes will range between 2" and 8" inside diameter. The pipes used must be non-metallic and corrosion resistant and shall have an internal pressure rating of at least 240 psi. The distance between the rib and closest inerting pipe wall shall not be less than 3' from the rib to the edge of the pipe. If more than one inerting pipe is installed in the seal, the horizontal distance between the pipes must not be less than 3' edge to edge. The number and size of pipes must be determined by the certifying PE. The number of pipes cannot exceed 5 per seal.

K. J-Seal Placement:

1. Installers will be trained by a Jennchem representative in safety, site preparation, form work installation, safe operation and calibration of pumping equipment, QC sampling, and filling and topping off procedures. The Jennchem representative will provide written certification.

2. A placer approved by Jennchem is the only machine currently approved for placement of the J-Seal grout. No alternative pumps may be used without prior approval from Jennchem. The horizontal length of the discharge hose shall not be less than 600' and shall not exceed 2,500'. However, Jennchem reserves the right to introduce new or modified equipment for the purpose of more efficient grout placement and update a longer pumping distance accordingly.

3. To protect the health of personnel, the work area shall be ventilated to maintain personnel's dust exposure at or below the applicable respirable dust standard. All personnel operating the placer pump shall wear necessary Personal Protective Equipment, including safety glasses with side shields, and NIOSH approved respiratory masks and hearing protection.

4. Calibration shall be conducted during the initial start-up of any seal, at mid-volume fill, and following any pumping interruption that requires hose clean-out. The Jennchem placer machine must be calibrated to determine the rate of material feed-in, check water powder ratio, and insure the density of the foamed grout is within the acceptable range. In the field, relevant information as listed in the calibration form shall be recorded. To verify the material quality at the discharge, either a volumetric yield test with a container or sample weight checking with a portable weighing scale shall be conducted in each calibration. Additional weight checking shall be conducted at one quarter fill and three quarter fill volumes in between the full calibrations. A J-Seal calibration form (Appendix Q-3) shall be completed during the process of each calibration. Jennchem reserves the right to improve the calibration procedure and update the calibration form format and content accordingly.

5. The person certifying the seal construction must not permit placing to begin until it has been verified that an adequate quantity of J-Seal is available, expected powder loading level is calibrated, sufficient labor is available, and competent operators are available.

6. The placement hose will be moved and positioned, as necessary, during placement, to provide uniform and complete filling of J-Seal grout between the form walls. To avoid any detrimental impact effect, the vertical drop (free fall)

of the fresh grout discharged from the nozzle shall not exceed 8' to the current level of the grout poured between the formworks.

7. To prevent voids, care shall be taken to direct the flow of J-Seal along the back of the form wall and into the corners of the formed area to insure complete filling against the formwork and at the roof and rib contacts. To avoid grout strength variation and weak spots or pockets within the seal, J-Seal powder and water will be fed in a consistent manner throughout the entire process.

8. The J-Seal discharged from the hose should be observed. Any changes from the normal appearance and consistency are sufficient reason to cease pumping and investigate the cause of the change.

9. Grout pumping shall continue until the space between the seal walls is totally filled, is confirmed fully-filled by evidence of returning grout in the bleeder pipes and/or by visual inspections (e.g. brattice cloth bulges out along roof line and/or grout starts to squeeze out from the interfaces).

10. In the event that pumping is interrupted, a cold joint may be unavoidable. To make sure the freshly placed J-Seal will develop effective bonding to the cured J-Seal grout, the hardened surface, if needed, shall be roughened with mechanical means, and free of debris and water. A roughness of the cold joint surface, greater than 2" over 4' measured with a flat edge scale, shall be generated and documented prior to resuming grout pumping. Jennchem shall document the approximate location of the cold joint(s) on the calibration form.

11. The curing temperature of the J-Seal grout shall not exceed 185°F. The curing temperature is governed by the bag mix, and no bag mix will exceed 16 bags/yd^{3}.

L. <u>Quality Control Sampling and Testing:</u>

1. A minimum of nine (9) samples from each seal will be taken, as follows: the first three (3) samples from the bottom will be taken once the entire floor is covered; the next three (3) samples will be taken from the middle once the J-Seal material reaches half the height of the seal; and, the last three (3) samples will be taken from the upper third of the seal height. Sampling for the test specimens must be done in a completely random and unbiased manner.

2. To minimize large air pockets and fill the sample mold full, each of the QC samples will be taken directly from a 5 gallon bucket or similar container that contains fresh J-Seal grout injected by the discharge hose. Each sample will be filled to the top of the mold, making sure that large air pockets are not entrapped during the sampling process. Any excess material shall be scraped off with a straight edge and the lid shall be secured in place. The

samples shall be labeled, sealed with tape, and placed in an uninsulated sample container. An empty bucket or similar container shall be used when taking another batch of QC samples. Emptying and refilling a sample mold after initial filling is not permitted.

3. Once all the samples are taken, the samples shall be stored in the sample box in an upright position. The samples are to remain at the seal location to cure under approximately the same conditions as the seal for the entire duration as specified in the approved ventilation plan and not removed earlier to take into account for "travel days" to the lab.

4. A few days prior to the planned curing age, the operator will contact a Jennchem representative to schedule pick-up and delivery of the samples to a certified testing facility.

5. All samples will be tested to determine the unconfined compressive strength. Samples shall be tested within 5 calendar days following removal from the mine. Samples shall be maintained at ambient conditions with no additional means of accelerated or enhanced curing. The average compressive strength must be greater than 410 psi with not more than two (2) samples testing below 410 psi, and no sample testing below 310 psi.

6. If the minimum average 410 psi is required in less than 28 days, an additional nine (9) samples can be taken and tested in less than 28 days to expedite verification that the minimum required strength has been achieved.

7. A penetration test will be conducted on each seal installed after the designated curing period using a Jennchem calibrated and approved penetrometer (with a nominal ¼" diameter head). Appropriate access ports/holes will be fabricated during seal formwork construction. For an average entry height of 48" or less, six (6) areas on the seal will be tested. Two tests will be made on each rib side, one near the upper roof/rib corner and the other near the mid-point between the floor and roof. The other two areas will be near the roof line near mid-span between the ribs and the other near the center of the seal. For an average entry height greater than 48", nine (9) areas of the seal will be tested. Three (3) tests will be made near each rib with a test near the roof and floor, and mid-way in-between. Two (2) additional tests will be near the roof line approximately 1/3 equidistance from rib to rib. One (1) test will be made at approximately near the center of the seal. For "Kennedy" and concrete block type formwork, access ports and/or holes will be fabricated into the formwork of the seal and the inby side covered with brattice cloth or similar material during pouring. After the test, the exposed area will be covered and sealed to protect the area tested from exposure to the mine air. A penetration test with a reading of 60 and 82 corresponds to 310 and 410 psi UCS, respectively. A passing test will be when the average of readings indicate a minimum average of 410 psi compressive strength. For an average entry height of 48" or less, only one (1) test result can be below 410

psi, and for greater than 48" average entry height, only two (2) can be below 410 psi. No results below 310 psi will be accepted for either entry heights. The test results will be reported on the same form as the compressive strength poured samples. If a test does not meet the minimum 410 psi strength requirement, additional penetrometer tests will be conducted at a later date and evaluated by the certifying PE who will determine if the structural integrity of the seal has been compromised. If a seal does not meet these strength requirements within 56 days after the initial pour, it will need to be replaced.

8. The seal will not be considered at design strength until the governing MSHA District recognizes the QC results (compressive strength and penetration test) as adequate.

M. <u>Site Certification by PE:</u>

A certifying PE shall be involved in the Site Certification process. Per the approved mine ventilation plan, the certifying PE visits the proposed site(s) and evaluates the field condition. The J-Seal must be constructed in a stable entry opening. The seal must not be located where a geologic feature, such as a fault or open joint, would compromise the performance of the seal. The certifying Professional Engineer (PE) may evaluate the minimum strata shear strength of 92 psi using existing rock mechanics data or relevant field test data of the strata surrounding the proposed seal. If multiple seam mining is present, the certifying PE will confirm that any additional stress will not be detrimental to the seal. Such information shall be included in the seal location certification that is to be provided to the MSHA District office.

If the field conditions meet the applicability requirements, the PE shall issue an Applicability Certification, which is attached to the Mine Ventilation Plan submitted by the mine to the MSHA District office for approval. Once approved, the certifying PE or the designee will conduct another site inspection after all preparations are complete including, formwork, gas sampling tubes, water traps, etc, are in place. If everything appears ready, the PE or the designee advises the operator to start pumping.

N. <u>Time Required for Seal to Reach Design Strength:</u>

Laboratory test results indicate that the approximate 13 bag J-Seal mixture reaches its intended strength typically after 28 days. A mixture with more than 13 bags/yd^3, but not exceeding 16 bags/yd^3, of J-Seal will achieve the minimum 410 psi strength in less than 28 days, and additional samples per the sampling protocol are necessary.

O. <u>Air Leakage and Seal Maintenance:</u>

1. The installed seal will be examined to ensure that J-Seal surface is not

exposed to the atmosphere. If the brattice or form is damaged, or the J-Seal is otherwise exposed to the atmosphere, the brattice will be repaired or other measures taken to cover the exposed J-Seal.

2. If air leakage is suspected, chemical smoke or other applicable methods approved by MSHA shall be used to determine quantity and location.

3. If air leakage occurs due to small fractures in the adjacent rock strata, a repair plan will be developed and submitted to MSHA for approval before implementation.

4. MSHA approved sealants will be used for non-structural repairs only in accordance with the manufacturer's specifications.

5. The repair plan will specify that the voids be filled with J-Seal grout, Marathan polyurethane, SealGuard II, or similar material with a minimum cured strength of 410 psi (unconfined compressive strength). The material shall have a minimum bond and shear strength of 92 psi. Bore holes shall be drilled into the strata and grout pumped into the strata using open-ended injection pipes until it is apparent the void is filled, as witnessed by grout returning back from the cracks. The seal shall then be checked for air leakage to ensure the fractures have been completely filled.

6. Prior to final approval by the governing District, only non-structural repairs can be made to the seal. Once the District Manager has acknowledged acceptance of the quality assurance test results for the seal, repairs to the seal are not permissible.

P. <u>Convergence Monitoring and Integrity Evaluation:</u>

1. The field seal convergence may be measured at outby roof mid-span using extensometers, "pogo" sticks, or any other approved measuring device. Each measuring device shall be initially marked and roof-floor convergence readings taken after seal installation at a frequency as specified by the governing District.

2. The structural integrity of a seal shall be monitored periodically (i.e. during the daily/weekly examination) after installation by examiners using proper methods, including visual inspection of cracks and crevices along the strata-seal interface and on the outby face, air leakage tests using chemical smoke or other MSHA approved means, and maximum seal convergence checks.

3. If the maximum allowable convergence exceeds 5%, a PE is to make an assessment of the site to determine if the 5% measurement is indeed attributed to convergence and if any structural damage has been done to the

seal. If the PE determines that the seals structural integrity has not been compromised and the seal can function as designed, a certified letter will be sent to the governing MSHA District with the PE's assessment. If structural damage to the seal is detected by the PE, then the seal must be replaced as prescribed by Federal Regulations. The governing MSHA District will establish the measuring criteria and monitoring frequency of convergence after the initial 5% threshold is reached and structural damage has not been detected.

Q. Contact Information:

For detailed information on the use and application of this seal, please contact Richard Adasiak, J-Seal Product Manager, Jennchem, or Fred Stafford, Vice-President, Jennchem, LLC, 258 Kappa Dr., Pittsburgh, PA 15238, phone number: 412-963-9071.

R. Miscellaneous - Authority and Notification Procedure:

If any part of these Installation Guidelines are not complied with, or if Jennchem personnel are directed by any personnel, including the certifying P.E., to perform some act not in compliance with these guidelines, the Jennchem Crew Supervisor has the authority to stop work on the seal, and immediately notify the J-Seal Manager, who in turn will notify Jennchem, Keystone Mining Services, and/or Jennmar corporate management, who will formulate and deliver an appropriate written response to the mine. Further, if during pumping/pouring of J-Seal material an event occurs that could compromise, or compromises the strength or integrity of the J-Seal material, as above, the Jennchem Crew Supervisor has the authority to stop all work on the seal and follow the above described notification procedure. If the event is determined to compromise the integrity of the J-Seal, an appropriate corrective action shall be implemented.

S. Appendices:

1. **Appendix Q-1:** Thickness Specification-Installation Table - Thickness Specification - Installation Table - Kennedy or Concrete Block Forms - 120 psi Main Line Seal

2. **Appendix Q-2:** Thickness Specification - Installation Table - Forms with Wood and Brattice or Forms with RIP prop, Welded Wire Mesh and Brattice - 120 psi Main Line Seal

3. **Appendix Q-3:** Blank J-Seal Calibration/Production Form

*J-Seal is the registered trademark and subject of U.S. Patent 9,011,043 B2

assigned to FCI Holdings Delaware, Inc.

Q-1. Thickness Specification - Installation Table - Kennedy or Concrete Block Forms
120-psi Main Line Mine Seal

Uniform Pressure 120 psi Safety Factor 1.5 minimum
Dynanmic Load Factor 2

Entry Height, ft	Max Allowable Convergence, in	Entry width, ft																
		14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
4	2.4	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
4.5	2.7	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00
5	3.0	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.00	8.04	8.10	8.16	8.21	8.26	8.31	8.35	8.39
5.5	3.3	8.00	8.00	8.00	8.12	8.24	8.33	8.43	8.52	8.60	8.68	8.75	8.81	8.88	8.93	8.99	9.04	9.09
6	3.6	8.22	8.38	8.54	8.68	8.81	8.92	9.04	9.13	9.23	9.31	9.40	9.47	9.54	9.61	9.67	9.73	9.79
6.5	3.9	8.68	8.86	9.04	9.19	9.34	9.47	9.59	9.70	9.81	9.91	10.00	10.09	10.17	10.24	10.32	10.38	10.45
7	4.2	9.14	9.33	9.53	9.70	9.87	10.01	10.15	10.27	10.40	10.50	10.61	10.70	10.80	10.88	10.96	11.04	11.11
7.5	4.5	9.55	9.77	9.99	10.17	10.35	10.51	10.67	10.80	10.94	11.06	11.18	11.28	11.39	11.48	11.57	11.65	11.74
8	4.8	9.97	10.20	10.44	10.64	10.84	11.01	11.19	11.34	11.49	11.62	11.75	11.86	11.98	12.08	12.18	12.27	12.36
9	5.4	10.69	10.97	11.24	11.48	11.71	11.92	12.12	12.30	12.47	12.63	12.78	12.92	13.06	13.18	13.30	13.41	13.52
10	6.0	11.42	11.73	12.05	12.32	12.59	12.82	13.05	13.26	13.46	13.64	13.82	13.98	14.14	14.28	14.43	14.55	14.68
11	6.6	12.03	12.39	12.74	13.04	13.34	13.60	13.87	14.10	14.33	14.54	14.74	14.92	15.11	15.27	15.43	15.58	15.73
12	7.2	12.65	13.04	13.42	13.76	14.10	14.39	14.68	14.94	15.20	15.43	15.66	15.87	16.07	16.26	16.44	16.61	16.78
13	7.8	13.18	13.60	14.02	14.39	14.76	15.08	15.40	15.69	15.98	16.23	16.49	16.72	16.94	17.15	17.36	17.55	17.73
14	8.4	14.00	14.16	14.62	15.02	15.42	15.77	16.12	16.44	16.75	17.03	17.31	17.56	17.82	18.04	18.27	18.48	18.69
15	9.0	14.16	15.00	15.14	15.57	16.00	16.38	16.76	17.10	17.44	17.75	18.05	18.33	18.60	18.85	19.10	19.33	19.56
16	9.6	14.62	15.14	16.00	16.12	16.58	16.99	17.40	17.77	18.13	18.46	18.79	19.09	19.39	19.66	19.93	20.18	20.43
17	10.2	15.02	15.57	16.12	17.00	17.10	17.54	17.97	18.37	18.76	19.11	19.47	19.79	20.11	20.40	20.69	20.96	21.23
18	10.8	15.42	16.00	16.58	17.10	18.00	18.08	18.55	18.96	19.38	19.76	20.14	20.48	20.82	21.14	21.45	21.74	22.02
19	11.4	15.77	16.38	16.99	17.54	18.08	19.00	19.06	19.50	19.95	20.35	20.75	21.11	21.48	21.81	22.14	22.45	22.76
20	12.0	16.12	16.76	17.40	17.97	18.55	19.06	20.00	20.04	20.51	20.93	21.36	21.74	22.13	22.49	22.84	23.17	23.49
21	12.6	16.44	17.10	17.77	18.37	18.96	19.50	20.04	21.00	21.02	21.47	21.91	22.32	22.73	23.10	23.48	23.83	24.17
22	13.2	16.75	17.44	18.13	18.76	19.38	19.95	20.51	21.02	22.00	22.00	22.47	22.90	23.33	23.72	24.12	24.48	24.85
23	13.8	17.03	17.75	18.46	19.11	19.76	20.35	20.93	21.47	22.00	23.00	23.00	23.43	23.88	24.30	24.71	25.09	25.48
24	14.4	17.31	18.05	18.79	19.47	20.14	20.75	21.36	21.91	22.47	23.00	24.00	24.00	24.43	24.87	25.30	25.70	26.10
25	15.0	17.56	18.33	19.09	19.79	20.48	21.11	21.74	22.32	22.90	23.43	24.00	25.00	25.00	25.39	25.85	26.27	26.69
26	15.6	17.82	18.60	19.39	20.11	20.82	21.48	22.13	22.73	23.33	23.88	24.43	25.00	26.00	26.00	26.39	26.83	27.27
27	16.2	18.04	18.85	19.66	20.40	21.14	21.81	22.49	23.10	23.72	24.30	24.87	25.39	26.00	27.00	27.00	27.36	27.81
28	16.8	18.27	19.10	19.93	20.69	21.45	22.14	22.84	23.48	24.12	24.71	25.30	25.85	26.39	27.00	28.00	28.00	28.35
29	17.4	18.48	19.33	20.18	20.96	21.74	22.45	23.17	23.83	24.48	25.09	25.70	26.27	26.83	27.36	28.00	29.00	29.00
30	18.0	18.69	19.56	20.43	21.23	22.02	22.76	23.49	24.17	24.85	25.48	26.10	26.69	27.27	27.81	28.35	29.00	30.00

Q-2. Thickness Specification - Installation Table - Forms with Wood and Brattice or Forms with RIP, Welded Wire Mesh and Brattice
120-psi Main Line Mine Seal

Uniform Pressure 120 psi Safety Factor 1.5 minimum
Dynanmic Load Factor 2

Entry Height, ft	Max Allowable Convergence, in	Entry width, ft																
		14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
4	2.4	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
4.5	2.7	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50
5	3.0	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.50	8.54	8.60	8.66	8.71	8.76	8.81	8.85	8.89
5.5	3.3	8.50	8.50	8.50	8.62	8.74	8.83	8.93	9.02	9.10	9.18	9.25	9.31	9.38	9.43	9.49	9.54	9.59
6	3.6	8.72	8.88	9.04	9.18	9.31	9.42	9.54	9.63	9.73	9.81	9.90	9.97	10.04	10.11	10.17	10.23	10.29
6.5	3.9	9.18	9.36	9.54	9.69	9.84	9.97	10.09	10.20	10.31	10.41	10.50	10.59	10.67	10.74	10.82	10.88	10.95
7	4.2	9.64	9.83	10.03	10.20	10.37	10.51	10.65	10.77	10.90	11.00	11.11	11.20	11.30	11.38	11.46	11.54	11.61
7.5	4.5	10.05	10.27	10.49	10.67	10.85	11.01	11.17	11.30	11.44	11.56	11.68	11.78	11.89	11.98	12.07	12.15	12.24
8	4.8	10.47	10.70	10.94	11.14	11.34	11.51	11.69	11.84	11.99	12.12	12.25	12.36	12.48	12.58	12.68	12.77	12.86
9	5.4	11.19	11.47	11.74	11.98	12.21	12.42	12.62	12.80	12.97	13.13	13.28	13.42	13.56	13.68	13.80	13.91	14.02
10	6.0	11.92	12.23	12.55	12.82	13.09	13.32	13.55	13.76	13.96	14.14	14.32	14.48	14.64	14.78	14.93	15.05	15.18
11	6.6	12.53	12.89	13.24	13.54	13.84	14.10	14.37	14.60	14.83	15.04	15.24	15.42	15.61	15.77	15.93	16.08	16.23
12	7.2	13.15	13.54	13.92	14.26	14.60	14.89	15.18	15.44	15.70	15.93	16.16	16.37	16.57	16.76	16.94	17.11	17.28
13	7.8	13.68	14.10	14.52	14.89	15.26	15.58	15.90	16.19	16.48	16.73	16.99	17.22	17.44	17.65	17.86	18.05	18.23
14	8.4	14.50	14.66	15.12	15.52	15.92	16.27	16.62	16.94	17.25	17.53	17.81	18.06	18.32	18.54	18.77	18.98	19.19
15	9.0	14.66	15.50	15.64	16.07	16.50	16.88	17.26	17.60	17.94	18.25	18.55	18.83	19.10	19.35	19.60	19.83	20.06
16	9.6	15.12	15.64	16.50	16.62	17.08	17.49	17.90	18.27	18.63	18.96	19.29	19.59	19.89	20.16	20.43	20.68	20.93
17	10.2	15.52	16.07	16.62	17.50	17.60	18.04	18.47	18.87	19.26	19.61	19.97	20.29	20.61	20.90	21.19	21.46	21.73
18	10.8	15.92	16.50	17.08	17.60	18.50	18.58	19.05	19.46	19.88	20.26	20.64	20.98	21.32	21.64	21.95	22.24	22.52
19	11.4	16.27	16.88	17.49	18.04	18.58	19.50	19.56	20.00	20.45	20.85	21.25	21.61	21.98	22.31	22.64	22.95	23.26
20	12.0	16.62	17.26	17.90	18.47	19.05	19.56	20.50	20.54	21.01	21.43	21.86	22.24	22.63	22.99	23.34	23.67	23.99
21	12.6	16.94	17.60	18.27	18.87	19.46	20.00	20.54	21.50	21.52	21.97	22.41	22.82	23.23	23.60	23.98	24.33	24.67
22	13.2	17.25	17.94	18.63	19.26	19.88	20.45	21.01	21.52	22.50	22.50	22.97	23.40	23.83	24.22	24.62	24.98	25.35
23	13.8	17.53	18.25	18.96	19.61	20.26	20.85	21.43	21.97	22.50	23.50	23.50	23.93	24.38	24.80	25.21	25.59	25.98
24	14.4	17.81	18.55	19.29	19.97	20.64	21.25	21.86	22.41	22.97	23.50	24.50	24.50	24.93	25.37	25.80	26.20	26.60
25	15.0	18.06	18.83	19.59	20.29	20.98	21.61	22.24	22.82	23.40	23.93	24.50	25.50	25.50	25.89	26.35	26.77	27.19
26	15.6	18.32	19.10	19.89	20.61	21.32	21.98	22.63	23.23	23.83	24.38	24.93	25.50	26.50	26.50	26.89	27.33	27.77
27	16.2	18.54	19.35	20.16	20.90	21.64	22.31	22.99	23.60	24.22	24.80	25.37	25.89	26.50	27.50	27.50	27.86	28.31
28	16.8	18.77	19.60	20.43	21.19	21.95	22.64	23.34	23.98	24.62	25.21	25.80	26.35	26.89	27.50	28.50	28.50	28.85
29	17.4	18.98	19.83	20.68	21.46	22.24	22.95	23.67	24.33	24.98	25.59	26.20	26.77	27.33	27.86	28.50	29.50	29.50
30	18.0	19.19	20.06	20.93	21.73	22.52	23.26	23.99	24.67	25.35	25.98	26.60	27.19	27.77	28.31	28.85	29.50	30.50

J-Seal Calibration/Production Report

Date: _____ Shift: _____Time:_____

Mine:_____ Seal location:_____

Team Leader:_____ Other Reps.:_____

Placer Unit No.:_____ Powder Feed Setting:_____

Water Flow Rate:_____ Water Temperature:_____

Hose Length:_____ Hose Diameter:_____

Output Pressure:_____ Bags Used:_____

Number of Samples taken:____

Calibration

Time to dump 5 bags (min & sec):_____= min + (sec/60) = _____ min.

(Powder pounds = 5 x 45 lbs = 225 lbs)

Throughput (powder pounds ÷ time) = _____ lbs/min

Water Rate (lbs/min X 1.0 divided by 8.34) = ___ gpm

Drum Size (Dia" x H"):_____ Volume = (Dia x Dia x H) ÷ (2,200): ____ ft3

Time to fill drum (min & sec): _____ = min + (sec/60) = _____ min

Output (Volume ÷ time): ____ ft^3/min

Powder lbs/yd^3 = (throughput ÷ output) x (27) = _____ lbs/yd^3

Mix Strength = (lbs/yd^3) ÷ (50):= _____ bags/yd^3

The following persons were on mine property and provided technical assistance and/or labor, on the above dates:

_____/_____hrs _____/_____hrs

_____/_____hrs _____/_____hrs

_____/_____hrs _____/_____hrs

_____/_____hrs _____/_____hrs

Signed,

_____ _____

Company Official Print Name and Title