INSTALLATION SPECIFICATION PENNGUARD™ BLOCK ON CARBON STEEL SUBSTRATES

1. SCOPE

1.1 This specification covers the recommended installation, quality control, and inspection guidance for the successful installation of the Pennguard Block lining system on carbon steel surfaces. For installation on concrete or ceramic brick substrates, consult Installation Specification CES-354. For installation on other metal substrates, such as titanium, high nickel alloy or stainless steels, contact Armor for guidance.

2. GENERAL

2.1 Pennguard Block is a glass material that requires care during handling, installation, inspection, and maintenance to prevent damage. Protect Block from chips, gouges, cracks, or impalement. Do not poke rods or other hangers into Block to suspend lighting, cords, or other equipment. Use protective boards over Block on floors to support scaffolding.

2.2 If gas stream has high particulate loading or velocity exceeding 100 feet per second (30 m/s), consult Armor. In elbows, on turning vanes, and at other changes in the direction of gas flow, the liner performance and longevity may benefit from special treatment for abrasion protection.

2.3 The following sign shall be posted on the exterior of the steel structure during and after lining application. “LINED EQUIPMENT, NO WELDING OR BURNING”.

2.4 Do not apply external insulation on any structure being lined with Pennguard Block and Pennguard Adhesive/Membrane unless specifically authorized in writing by Armor. External insulation retains heat that will overheat the Adhesive and reduce its bond to the Block.

3. EQUIPMENT AND SUPPLIES

3.1 To mix Pennguard Adhesive/Membrane, use a heavy-duty variable speed drill with a 3/4" (16-18 mm) chuck and sufficient torque to deliver a minimum speed of 230 rpm under load. The drill shall be fitted with a Jiffler mix blade, Model DC312, with 2 x 6.5" (165 mm) propeller blades. Use of any other equipment to mix Pennguard Adhesive/Membrane requires prior written approval from Armor, as incomplete mixing can prevent full cure and severely compromise system performance.

3.2 Insulation saws and rasps, to cut and sculpt the Pennguard Block.

3.3 Flat edged masons' trowels of a size approximately 8" (200 mm) long x 3" (75 mm) at the heel with end rounded (preferably not pointed) to approximately 3/4" (20 mm) radius to apply the Adhesive. Do not use a notched trowel.

3.4 Lanolin-based waterless hand cleaner.

3.5 4" (100 mm) wide stiff-bristled paint brushes, paper coveralls, rubber dish-washing gloves, rags, wire brushes.

3.6 Mineral spirits to remove wet Pennguard Adhesive/Membrane from tools, such as trowels and mix blades, and loosen cured Pennguard Adhesive/Membrane

3.7 Set of latest installation specifications, drawings, SDS's and product information sheets for all lining materials.

3.8 Dewpoint meter, electronic temperature meter, adequate lighting, especially in a dark chimney where application is taking place, surface thermometers, white (non-wax) marking chalk or white spray paint, a timer. PPE shall be determined by the contractor and shall comply with local regulations.

4. MATERIAL, ENVIRONMENTAL, AND SUBSTRATE CONDITIONS

4.1 The product and substrate temperatures are important. In cold conditions, the product storage and construction areas shall be heated to achieve and maintain the temperatures outlined below.

4.2 At the time of mixing and application, the temperature of the components should ideally be between 70°F (21°C) and 90°F (32°C).

4.3 The temperature of the prepared surface shall be at least 5°F (3°C) above the moisture dew point and between 50°F (10°C) and 95°F (35°C) at the time the Pennguard Block Lining System is applied.

4.4 The work site must be protected from precipitation. The cartons of Pennguard Block and containers of Pennguard Adhesive/Membrane and primer shall also be protected. Chimneys are typically covered at the top during lining work to prevent ingress of rain.

5. SURFACE PREPARATION

5.1 All welds shall be continuous. Intermittent or spot welding shall not be permitted.

5.2 All weld spatter, slag, and old anchor welds shall be removed from the substrate, and the area ground flush with the parent metal.

5.3 Gross pinholes, pits, blind holes, porosity, undercutting, or similar depressions should not exist in the finished surface of the weld before or after blast cleaning. Use a suitable steel repair paste to repair.

5.4 All edges and fillets and similar abrupt contours shall be rounded off smoothly by grinding or machining. A 1/8" (3 mm) radius is preferable. Smooth, ripple finished welds are acceptable.

5.5 Plates welded together shall be properly aligned; butt welded joints are preferred.

5.6 Lap welded joints should be avoided wherever possible. If lap-welded joints are used, they must be fully welded on the inside.

5.7 Flue liner sections can be joined by welding or using gasketed, bolted flanges. It is important there is a full seal weld used when welding sections. All weld spatter must be removed.

5.8 Structural reinforcement members should be installed on the vessel exterior and must be installed before commencement of lining work.

5.9 Unless otherwise specified in writing by Armor, a commercial blast finish as specified by most current revisions of SA 2.0 or SSPC SP6 is required for preparing carbon steel surfaces to receive the lining.

6. PRIMER

6.1 To prohibit the formation of rust and rust bloom after blasting, carbon steel should be primed with Pennguard HP Epoxy Primer.

6.2 Mix and apply Pennguard HP Epoxy Primer in accordance with Armor specification CES-150.

7. MIXING OF ADHESIVE/MEMBRANE

7.1 Remove the lid from the Pennguard Adhesive/Membrane pail. Inspect for damage incurred during transit.

7.2 Ensure that there are no leaks in the Part B Hardener container, there is no water present on or in the Part A Base component, and the pail is free of dents in the side wall that Block the mix blade's access to the bottom corners of the pail.

7.3 Using drill mixer and mix blade specified in section 3.1, pre-mix Part A by itself for a minimum of one minute to loosen the base component.

7.4 A good mixing technique involves movement of the rotating blade within the pail. Move the blade around the base of the pail in a circular motion. Simultaneously lift the blade from the base of the pail without bringing the blade above the surface of the compound and continue the circular motion around the side of the pail. During mixing, hold the mix blade occasionally at a 30-degree angle within the mixture, to ensure all contents of the pail are thoroughly mixed. Pay close attention to contact all surfaces of the pail with the mix blade. Make sure to mix in the corner of the pail.

7.5 Automated mixing machines specifically designed for this purpose can also be used to mix Pennguard Adhesive/Membrane. Consult Armor for more details.

7.6 Open Part B Hardener. While mixing Part A Base Resin, take a full 15 to 20 seconds to slowly pour Part B into the center vortex created by the mix blade in Part A.

7.7 When the material temperature is 65°F (18°C) or higher, mix for at least three (3) minutes using a good mixing technique to yield a uniform mixture. When the temperature of the components is 60°F or below (15°C), mix for at least four (4) minutes using a good mixing technique to yield a uniform mix. Use a timer to prevent under mixing.

7.8 Pennguard Adhesive/Membrane is ready for use immediately after mixing; however, if left undisturbed after mixing, it will thicken over time.

7.9 Protect unmixed Membrane components and mixed material from any contact with moisture or other contaminants.

8. INSTALLATION

8.1 Before applying Pennguard Block, the contractor shall check the flatness of the prepared substrate in any area which visually may indicate a seating problem. This shall be performed by taking a straight edge of the specified length of the Block to be installed and placing it dry against the prepared surface in the orientation in which it will be installed. If there are any gaps between the substrate and the straight edge greater than 1/8" (3 mm) or if the straight edge rocks on a high point rather than sits firmly on the surface, properly mark the area. Either remove the imperfection in the substrate or cut the standard size Block being used to minimize the effect of the substrate variation and allow a full bond of the Block to the substrate using the Pennguard Adhesive/Membrane. A comparable check shall also be applicable to lining curved surfaces.

8.2 Trowel apply a minimum 1/16" (1.5 mm) thickness of Pennguard Adhesive/Membrane onto the substrate with a suitable trowel as specified in section 3.3 carrying the coverage to approximately 2" (50 mm) beyond the area the Pennguard Block will cover when it is placed in position. The size of the area to which the Pennguard Adhesive/Membrane is applied at any one time shall be no greater than will allow the area to be lined with the Block before the Adhesive on the substrate loses its tackiness.

8.3 Trowel a minimum of 1/16" (1.5 mm) thickness of the Pennguard Adhesive/Membrane onto the back, one long, and one short side of the Pennguard Block to be installed, such that the buttered sides will be abutting previously installed blocks. In positioning the Block against the Adhesive applied to the substrate surface, move the Block back and forth at least 2" (50 mm) a couple of times while sliding it into place against the adjacent Block to remove voids between the Block and the surface. Be sure to maintain a minimum of 1/8" (3 mm) joint thickness Block to Block and Block to substrate. Adhesive shall totally fill side joints and shall be seen to ‘bead’ along edges without exception at the Block corners. Listen for the grinding sound of Block scraping against Block or the substrate. This is a sure indication of insufficiently filled side joints. Strike the joint surfaces clean to trim Adhesive squeezed out during placement of the Block.

8.4 It is very important that the Block coated with Adhesive has full contact with the Adhesive applied to the substrate surface, whether it be flat floors, side walls, overhead areas, curved surfaces, etc.

No voids shall be left between the Block and the substrate or between the layers of Adhesive coating them. Cut the Block and create an extra joint when necessary or increase thickness of the Adhesive back joint to exclude voids and gaps. Side and back joints must be full joints and shall not be less than 1/8" (3 mm) thick.

8.5 Side joints shall be struck clean after installation, with attention to removing excess material from the face of the Block. Before moving to a new work area or at appropriate times such as shift changes or scaffold/platform movements, inspectors shall thoroughly inspect surface to detect presence of any excess Adhesive and direct that it is to be removed promptly.

8.6 If the applied Adhesive is still tacky enough to blacken a gloved finger when touched, additional material can be applied over it to continue installing Pennguard Block. If it has cured beyond this stage and transfers no color to a glove when touched, it must be scraped off. This procedure is critical since wet Adhesive will not bond well to cured Adhesive.

8.7 Cured Adhesive that does not pass the gloved finger wet-tack test must be abraded to roughen the surface and remove any surface gloss using wire brushes.

8.8 When work stoppage is anticipated, remove as much of the wet Pennguard Adhesive/Membrane as practical from the leading edge of the completed lining. Leave a blackened leading edge of nominal 2-3” (50-75 mm) to marry onto for the next shift’s work. Should the time frame between a work stoppage and restart exceed 48 hours, use a wire brush to remove excess Adhesive and degloss cured Adhesive residue.

8.9 Do not install Block that are cracked, gouged, or have other imperfections. Do not install Block with chipped corners.

8.10 Staggered or broken bond construction is recommended to minimize four corners meeting and the possibility of a corner void.

8.11 If partial Blocks are used, the minimum size shall be a one third (1/3) piece of Block. If the remaining gap is less than one third of a Block, reduce the dimension of the final two Blocks to maintain this minimum Block size. Avoid using small sliver-sized pieces.

8.12 When flues are fabricated in sections (cans) for field erection, finish the last row of Block back from the edge of the can a minimum of 6” (150 mm) so the leading edge is not damaged during erection. This 12” (300 mm) joint will be completed after the sections are erected and joined in the field.

8.13 All sections that are to be welded must be seam welded. The welding must be performed before installing the final row of Block to seal the sections. If welding is done internally, remove weld spatter and remnants of damaged primer from the welding. Use EXTREME CAUTION and take all necessary precautions against potential for fire when welding. Keeping a working fire extinguisher close by is highly recommended. The previously laid Block adjacent to the sections will have exposed Membrane that is particularly flammable before it has reached full cure and still contains solvent.

8.14 Ensure there are no gaps between flanged sections after they are fully bolted together. It is good practice to use a gasket for the flanged sections or alternately use a layer of catalyzed Pennguard Adhesive/Membrane to create a wet gasket before bolting the sections tight together.

9. CURING OF LINING

9.1 In general the lining may be placed into service after curing for 24 hours at 70°F (21°C).

9.2 Contact Armor for special cure schedules if downtime does not allow enough curing of the lining as outlined above.

9.3 Consult Armor if initial startup temperatures may rapidly exceed 250°F (120°C).

10. INSPECTION AND QUALITY CONTROL

10.1 The mixing, curing, and adhesion characteristics of Pennguard Adhesive/Membrane shall be evaluated by applying it onto a test area of the same material and surface preparation of the production substrate. Work life and initial set time may be visually observed. Work life is the maximum time the Pennguard Adhesive/Membrane remains trowelable. Initial set time is defined as the time between mixing Pennguard Adhesive/Membrane and when it is no longer wet to the touch.

10.2 The installation procedure of the lining system shall be verified by using Cure Verification Cards (CVC) as supplied for the project. Cards should be retained throughout the duration of the project to ensure cure of all applied batches. The location of specific batches in the chimney shall be noted and checked the next day against the CVC cards. It is good practice to number each sequential row of applied Block with chalk as the work proceeds.

10.3 Inspectors shall determine the frequency of random site checks to determine back joints have complete contact by pulling random blocks while the adhesive is still wet and visually verifying the back joint and side joints are completely full.

10.4 A photographic history of surface preparation, primer application, adhesive application, and block installation is suggested.

11. REPAIR OF MECHANICALLY DAMAGED AREAS

11.1 Experience indicates that repair of an area smaller than a standard size Block requires more effort than a larger area.

11.2 Cut out a minimum of a full Block down to Membrane on substrate. Remove remaining Membrane on substrate as best as possible to expose underlying substrate. Clean the Pennguard Adhesive/Membrane using a wire brush to remove excess Adhesive and de-gloss cured Adhesive residue. Reinstall Block as outlined previously.

12. ABRASION RESISTANT SURFACE TREATMENT IN HIGH VELOCITY AREAS

12.1 Consult Armor for details on specifying additional treatments for the Block surface where abrasive environments are anticipated.

13. STOP BARS AND LINING TERMINATION

13.1 The Pennguard Block Lining System should not be terminated with a free edge. It must be placed against flat stop bars to protect the leading edges. The height of the stop bar should be the full lining thickness. The stop bar shall be of an alloy grade suitable for the anticipated service. Stop bars should be used if the Pennguard Block Lining System abuts manway openings, expansion joints, dampers, pipe stubs, or sample ports and where the lining terminates at the top of the chimney.

14. EXTERNAL INSULATION

14.1 Do not apply external insulation on any structure being lined with Pennguard Block unless specifically authorized in writing by Armor. External insulation retains heat that will overheat the Adhesive and reduce its bond to the Block.

15. FLOOR PROTECTION

15.1 Pennguard Block installed in areas such as horizontal ductwork or chimney floors may be subjected to mechanical damage caused by maintenance procedures such as removal of fly ash carry-over. Consult Armor for additional protection details.

16. DRAINS

16.1 Horizontal ducting and chimney floors shall incorporate adequately designed drainage to ensure condensate is removed and drains do not plug.

17. SAFETY PRECAUTIONS DISCLAIMER CONTACT INFORMATION

17.1 Consult current Safety Data Sheets (SDS's) before commencement of work.

17.2 While statements, technical information and recommendations contained herein are based on information our company believes to be reliable, nothing contained herein shall constitute any warranty, express or implied, with respect to the products and/or services described herein, and any such warranties are expressly disclaimed. We recommend that the prospective purchaser or user independently determine the suitability of our product(s) for their intended use. No statement, information, or recommendation with respect to our products, whether contained herein or otherwise communicated, shall be legally binding upon us unless expressly set forth in a written agreement between us and the purchaser/user. For all Terms and Conditions of Sale see armor-inc.com.

17.3 Please contact Armor for further information at +1-877-98ARMOR (982-7667) or customerservice@armor-inc.com.