Pennguard Block Lining System - The Acid resistant Chimney Lining

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Ben Beck

Ben Beck is Business Development Manager at Hadek Protective Systems, a leading supplier of internal lining systems for power plant flue gas ducts and chimneys. Since Spring of 2006, Ben has been involved in the design and application of Pennguard Block Lining Systems for new and existing power station chimneys in the US. Ben Beck received his Masters of Science Business Administration from California University of Pennsylvania in 2002.

1. Introduction

In the spring of 2006, Commonwealth Dynamics, Inc. selected Hadek to supply and install a borosilicate block lining system for two (2) 450’ (137 m.) tall reinforced concrete chimneys that Commonwealth was building at TXU’s Oak Grove Electric Station in Robertson County,Texas. Each chimney has one (1) 32’ (9.75 m.) I.D. steel flue that is protected from the corrosive flue gas environment with Hadek’s borosilicate block lining system.

Commonwealth Dynamics, Inc. was contracted by Fluor Constructors to build the chimneys on this project as part of a new Wet Flue Gas Desulfurization system that Fluor was installing for TXU at this 1,600-MW power plant in central Texas. Upon completion, the Oak Grove Power Project earned POWER Magazine’s highest honor as recipient of their 2010 “Plant of the Year” award.

As a service to the chimney builders in the United States that were very busy at the time, Hadek Protective Systems offered to install the Pennguard Block Lining System, utilizing Hadek’s man power. The lining of both units was executed by Hadek Protective Systems, Inc. as well as supply of the Pennguard® Block Lining System materials. Included with the supply of materials was the QA/QC supervision. The inspections were performed according to an Inspection and Test Plan containing four discrete phases of the installation process.

The installation of the lining system and all preparatory work was done from a moving platform combined with a fast moving materials/personnel basket. The breeching duct was completed from fixed scaffolding. To reduce weather influences, the flue was closed off from the environment and could be completely conditioned.

A Pennguard Block Lining System installation can be divided in four distinct phases. An Inspection and Test Plan is specifically made for a project and addresses the phases in protocols 1,2,3, and 4. As each phase of the lining application was completed, the installation contractor and Hadek’s QA/QC representative signed off.

2. Execution of work

2.1. Platform

The platform was used to carry out all the blasting, priming, block laying and inspections. The platform was designed and supplied by Spider of Houston, TX. It was constructed of aluminum beams and grating and was operated with 9 electric motors. To distribute equal weight on the platform, 6 motors were used near the circumference of the platform while the remaining 3 motors were near the center of the platform. The center of the platform was left open for the man/materials cage. The cage was mainly used for transporting personnel and materials to and from the platform, to prevent the platform from traveling up and down, affecting production.

Figure 1 Platform shown from below

The transformer for the platform was situated on the platform, with a single 500' (152 m.) power cable connected from ground to the transformer. Keeping the transformer on the platform reduced the amount of cables hanging below the platform and reduced the chances of cables tangling. Additionally, 15 safety lines were suspended from the top for the crew, inspector and visitors to tie-off during block application.

2.2. Protocol #1

The first protocol consists of Acceptance of Substrate. Inspections of the weld seams, stop bars and test ports are discussed in this protocol. All welds on the substrate to be lined should be full and continuous and any leading edge should receive a stop bar. Welds may not protrude more than 1/8" (3 mm.) from the substrate.

An essential part for uninterrupted work is environmental conditioning. To close off the top of the chimney, it was covered with 2 tarps that were secured with ropes. This was to ensure that the tarps would not be torn during high winds or heavy rain. The tarps were installed in a small dome shape so during heavy rain, the water would flow down on the sides instead of forming puddles on the tarp itself. Also, the absorber end of the inlet was closed using tarps and ropes.

The Pennguard® lining application requires a dust free substrate with specific climate control parameters, defined by the air temperature, humidity, and substrate temperature. Once all necessary openings were closed, the ideal climatic conditions were achieved in the chimney using equipment rented from Munters. All required climatic conditions were provided to Munters and they supplied equipment based on their calculations for air changes needed to maintain the conditions.

During Fall/Winter time, for Unit 1, the equipment was set up on the ground and consisted of a DX - 30 Ton Air-conditioning unit and a dehumidifier HC 4500 unit. The HC 4500 unit was able to generate cold or hot air. During the cold month of December, only the HC 4500 unit was used, which was able to generate hot, dry air to maintain the ideal working conditions. During spring/summer time for Unit 2, the HCU-6000 unit was used, which combines cooling and desiccant dehumidification technology. This unit was sufficient to maintain and provide necessary climatic conditions.

Figure 2 Flue cover with tie-downs

Also, using just one unit resulted in lower cost overall for rent, fuel and the generator compared to the Unit 1 equipment.

Due to the equipment's high power demand, a generator was needed for their operation. A 250 kW generator was used to operate both of the Munters units. A 600-gallon diesel tank was used as a fuel source. During the blasting activity, the equipment was kept running 24 hours a day to maintain and hold the blast, one worker was assigned at the end of the night shift, to oversee the equipment until the day shift resumed. During blasting activities, on Sunday one person had to be present as a 'fire watch' while the equipment was in operation.

2.3 Protocol #2

The second protocol is Acceptance of Substrate Preparation. The substrate was grit blasted to an SSPC-SP10 cleanliness with no specific profile. Temperatures, humidity and substrate cleanliness were inspected regularly during the blasting process.

Figure 3 Blasting equipment

The blasting activities were carried out in 2, 10-hour shifts per day. The crew consisted of 3 persons blasting on the platform, while 1 was attending the blast pot, compressor and miscellaneous items on the ground. In addition, one operator to load the bags in the blast pot and 1 superintendent were always present along with a safety officer.

All the abrasive blasting equipment was rented from Marco, based out of Houston, TX. One 8-ton bulk blast pot was utilized during blasting activities in both chimneys. The bulk blast pot was equipped with 4 outlets, of which 3 outlets were used full-time and the fourth was used as a back-up. The bulk blast pot was loaded using a forklift and team of 2 crew members whenever necessary. Closing all the openings and using Munters equipment enabled us to blast-clean the entire chimney continuously, without switch of activities. During the blasting activities of both Unit 1 and Unit 2 projects, back -up Munters equipment was also present on-site in case the operating equipment happened to malfunction.

Figure 4 Steel surface during blasting

A Sullair 750 CFM (21.23 m^3/min.) air compressor was used during the blasting activities. The compressor was rated at 150 psi (1034 kPa) output pressure. The nozzle pressure at any given instance was 90 psi towards the top of the chimney and as the platform travelled down, the nozzle pressure steadily increased, which increased the production rate. The 90 psi (621 kPa) was the minimum pressure needed to remove the tight mill scale on the new steel substrate. Almost all of the 750 CFM (21.23 m^3/min.) output was used during the blasting activities. Each nozzle required 200 CFM (1379 kPa), approximately 15-20 CFM (103-138 kPa) for each blast hood and approximately 25-40 CFM (0.7 - 1.1 m^3/min.) on the after cooler. A total of 3 nozzles, 3 blast hoods and 1 after cooler were used during the blasting activities. A back-up compressor was also present during the blasting/priming activities

The compressor air was directly connected to the 950 CFM (27 m^3/min.) Air-prep system. This system is used to clean, cool, and dry the compressed air. It is designed to remove moisture and contaminants that shorten the life of equipment controls and decreasing blasting efficiency. The system was rated at maximum working pressure of 150 psi (1034 kPa) .

The blast hose used were 1.25" (32 mm.) in diameter with brass couplings. Each section of hose was 50' (15.2 m.) in length, for each blaster, a total 500' (152 m.) of blast hoses were connected with safety clips, swivel whips and safety checks. This ensured that during blasting, none of the sections of the blast hoses came loose, affecting the production and more importantly, the safety of the crew.

The nozzle used for abrasive blasting was a 6" brass poly nozzle, which is a durable, heavy-duty nozzle. At any given stage of the blasting process, this combination of the compressor, blast hose, and nozzle resulted in use of 1050 – 1200 lbs/hr (476 - 544 kg/hr) of abrasive at 90 - 100 psi (621 – 689 kPa) pressure at each nozzle. This resulted in approximately 125 – 150 ft^2/hr (11.6 – 13.9 m^2/hr) in worker's production. The production rate was higher at lower heights and loose mill scale areas on the steel substrate.

The abrasive used to clean the steel substrate was red garnet, 30/60 size. It is a more durable abrasive, compared to other blast materials. The garnet cuts faster and significantly increases productivity. Blast cleaning with garnet resulted in lower dusting because of its toughness and rapid settling due to its high specific gravity. The QA/QC inspections during the blasting activities were fast as there was not much time wasted for the dust to settle.

Once blasting was completed and cleanliness approved, the second and important step followed by cleaning the substrate and the platform. Substrate and platform were first cleaned with air hose, connected to the compressor. After all the dust had settled it was removed. The substrate was then cleaned with shop-vacs. This ensured a dust-free substrate during the priming application. After the blast-cleaned substrate was accepted, the cleaning activities followed.

The used abrasive during blasting had settled on the chimney floor. Dust and debris was removed from the chimney floor by using an industrial vacuum supplied by Marco, for Unit 1 and an industrial size 'Super-Sucker' truck, for Unit 2.

2.4 Protocol #3

The third protocol defines Acceptance of the Primed Substrate and covers the phase in which the prepared substrate is primed. Temperatures, humidity, mixing of the primer, application and technique are inspected during this activity.

The primer application was carried out with a crew of 6 on the platform. 3 persons for cleaning a second time using shop vacuums, two for painting and 1 for mixing the two-component Pennguard Block Primer. The priming was carried out using an airless spray pump. The pump was situated on the platform during the priming process. Graco spray guns were used to spray the primer. The primer was sprayed to achieve a wet film profile of 5 – 10 mils (0.13 – 0.25 mm.) and dry film thickness of 0.6 - 1.1 mils (0.015 – 0.028 mm.).

When the primed surface was completed and accepted, protocol 3 was signed and installation of the Pennguard Block Lining System, commenced.

2.5 Protocol #4

The fourth protocol identifies the Acceptance of the Pennguard Block Lining System. During application of the Pennguard Block Lining System, regular measurements are taken on temperatures and humidity and documented. The mixing of the two-component Pennguard Adhesive Membrane was regularly checked and from each pail a sample card was collected and stored to check curing of each pail. All daily activities were recorded on daily reports and are signed by the Hadek QA/QC personnel and the customer. The installation of the Pennguard Block Lining System consisted of application of te Pennguard Adhesive Membrane and the Pennguard Blocks, to the substrate. Using a double buttering technique, the Pennguard Adhesive Membrane was first applied to the substrate and then to a Pennguard Block, both on the back and sides after which it was placed to the substrate and slid into place, thus removing any air behind the block and ensuring a 1/8" (3 mm.) side, back, and bed joint.

The tools used for the Pennguard block application were a duck-built trowel, a float and a saw. The Hadek mixing machines were used to mix all of the membrane, using a Jiffy Blade, model PS-21.

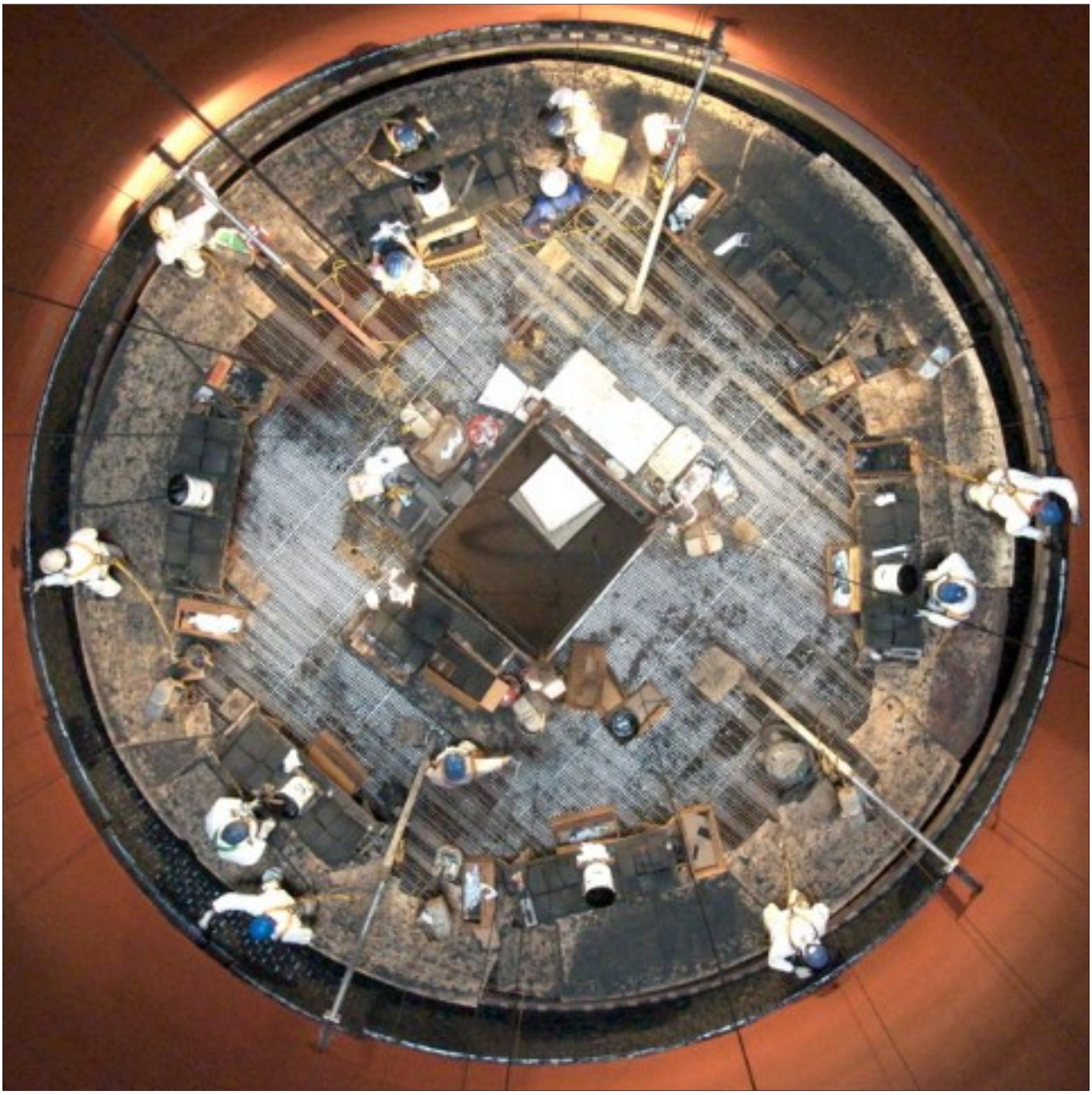

Figure 5: Installation of the Pennguard Lining System