MIRANT USES PLASTIC LINERS AND AIR CANNONS TO MAINTAIN COAL FLOW

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Introduction

To better meet the required emissions reductions at coal fired power plants, coal is washed at the mine before shipment to the end user. The additional handling of the coal from the washing process increases the amount of fine coal particles and surface moisture in the delivered coal. Coal handling equipment designed for coarser and dryer coal can become plugged, leading to costly curtailments. Correcting flow problems may require a combination of technologies.

Dickerson Generating Plant

Dickerson operates three baseload units and three peaking units, with total capacity of 853 megawatts- enough electricity to power nearly 853,000 homes. This is about 7 percent of Maryland's in-state generating capacity. The Dickerson Plant was built in 1958 and Units 1,2 & 3 are Babcock & Wilcox pulverized coal boilers, which supply steam to (3) General Electric turbines.

Electric Generating Unit	Fuel Source	Type of Dispatch	Generating Capacity
Unit 1 - Steam	Coal	Baseload	182 Megawatts (MWs)
Unit 2 - Steam	Coal	Baseload	182 MWs
Unit 3 - Steam	Coal	Baseload	182 MWs
Dickerson D/Combustion Turbine (CT) 1	Oil	Peaking	13 MWs
Dickerson H/CT 1	Gas/Oil	Peaking	147 MWs
Dickerson H/CT 2	Gas/Oil	Peaking	147 MWs

Coal

The Dickerson Station burns bituminous coal supplied from coal mines located in the Central Appalachian region of West Virginia. The particle size distribution of the received coal ranges from 2" maximum with 75% 1" minus and 50% ¼" minus. The moisture content averages 5.5% and ash content is about 9.8%. Annual coal consumption is nearly 1.5 million tons or an average daily burn of a little more than 4,000 tons.

Description of Coal Handling System

Coal is received at the plant in railroad cars which are emptied by a rotary car dumper. Coal can be stockpiled in the coal yard, or fed directly into the plant.

Whether being reclaimed from the pile or fed directly from rail cars; coal entering the plant is fed to a conveyor with a motor operated tripper for distributing coal to the three main bunkers, one for each coal-fired unit.

The coal handling system from the tripper car to the volumetric rotary feeders consists of (3) 3000 ton coal storage bunkers, one for each generating unit. Each coal bunker is 45 feet high from the top of the discharge hoppers to the tripper conveyor floor and is constructed of carbon steel with carbon steel interior sloping walls that transition down to (8) pyramidal discharge outlets, measuring 4' x 4' square. The slopes in the discharge hoppers are between 57° and 59°. Beneath each of these outlets are (8) transition hoppers that taper down to 2' x 2' square discharge outlet. Each transition hopper has a ledge about halfway down that includes a door that enables observation of the coal flow. Located beneath the 2' x 2' discharge outlets are (4) auxiliary hoppers that combine the coal flow from two discharge outlets into a single coal stream which feeds the volumetric rotary feeders (See Figure 1). In the late 90's the plant owners lined the interior surfaces of the (8) transition hoppers and (4) auxiliary hoppers, with stainless steel to reduce surface corrosion and improve coal flow within this region.

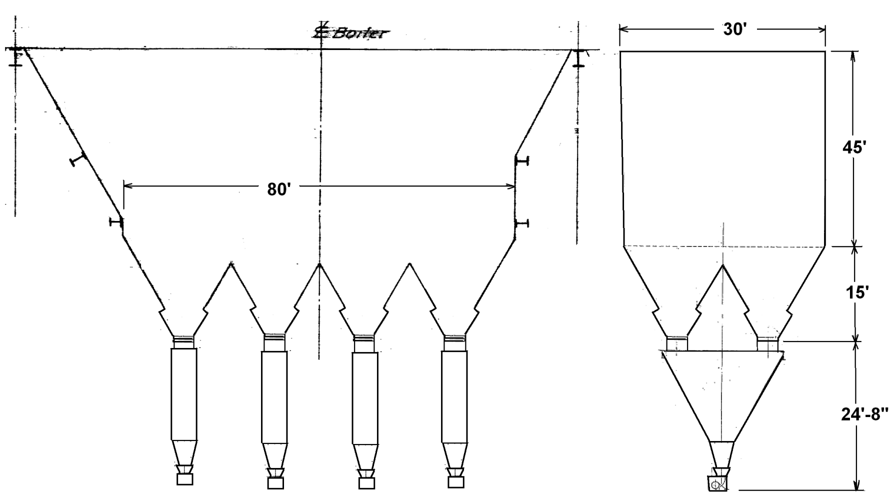

Figure 1: Arrangement of Coal Bunkers

Figure 2: A view of the (8) discharge outlets as viewed underneath Unit # 2 coal bunker.

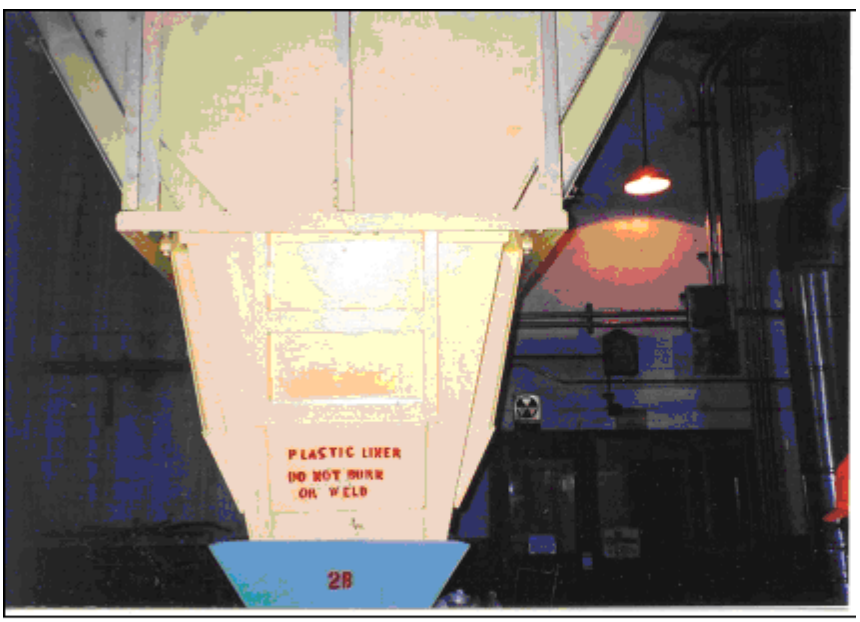

Figure 3: The (4) auxiliary hoppers, feeding the volumetric feeders

Figure 4: A view of the volumetric rotary coal feeders.

Description of Problem

Frequent loss of coal flow during operation limited the ability of these units to make and maintain full load. Loss of coal flow was attributed to plugging issues starting at the 4' x 4' discharge outlet elevation of the coal bunkers and extending down through the (8) transition hoppers and (4) auxiliary hoppers located above the volumetric feeders. Operators responded to the loss of coal flow using air lances inserted through the observation doors and hammering on the sloping wall surfaces of the discharge hoppers. Except during very dry weather, plugging occurred on a daily basis. During periods of extreme wet weather or coal laden with ice and snow, laborers were continually stationed around the discharge hoppers with sledgehammers and air lances to keep coal flowing.

Inspection of the (8) transition hoppers and (4) auxiliary hoppers revealed a significant build-up of coal in the sloping valley angles. The coal deposits had accumulated over the years in an area not impacted by coal flow. Under the coal deposits, the stainless steel had corroded, making the coal deposits adhere more to hopper walls (See Figure 5). The build-up of coal in the valley angles of the hoppers was determined to be the result of higher moisture content fuel and the smaller size of coal particles. The original design fuel was to be 4.6% moisture, but coal presently supplied to the station is about 9.8% moisture. Once coal began to build-up in the valley angles, it would then continue to migrate into the primary flow stream, eventually choking off coal flow, resulting in load generation curtailments.

Figure 5: Buildup of coal in the corners of the discharge hopper and surface corrosion and pitting on stainless steel liners.

Solution

In an effort to reduce the generation curtailments resulting from coal flow problems in the lower portion of the coal bunkers on Units # 1, 2, & 3, the plant installed air cannons through the doors angled downward into the transition hoppers (See Figure 7). A total of eight air cannons were installed on each unit, one in each auxiliary bunker. The air cannons do not operate continuously, but are on a firing sequence initiated when the volumetric feeders under their respective discharge outlets loses coal flow as determined by a drop in feeder motor amps. After the installation of the air cannon coal flow was improved, but required extensive usage on a daily basis.

Figure 6: Air cannon installed on transition hopper.

In a continuing effort to improve coal flow and reduce output curtailments the Mirant/Dickerson engineering team made the decision to install TIVAR® 88 liners on the sloping wall surfaces of the transition and auxiliary hoppers in Units 1, 2, & 3. Sticking, ratholing, and stagnant coal in storage bunkers are problems that many power plants deal with, on a daily basis. TIVAR® 88 [1] polymer liners have proven to be a viable option for improving coal flow by reducing the coefficient of friction between coal and the sloping wall surfaces of bins, bunkers and silos. TIVAR® 88 can produce a lower coefficient of friction than 304 2B stainless steel, with many types of coal and other cohesive bulk solids. This lower coefficient of friction surface artificially increases sloping wall angles and valley angles in bunkers, bins and silos, thus improving material bulk material flow. TIVAR® 88 also provides excellent slide abrasion wear resistance, is chemically inert, has zero moisture absorption and is lightweight at 1/8 the weight of steel. Many people refer to it as the “silent performer”. Unlike the air cannon, vibrator,

[1] The "plastic" liner incorporated was a material called TIVAR® 88 manufactured by Quadrant EPP. The TIVAR® 88 liner is an "engineered plastic" UHMW-PE material with additives to reduce the C.O.F. and also enhance the abrasion resistance of the liner.

air lance and sledge hammer, it does not require any outside assistance and/or energy source to perform.

Prior to the installation of the TIVAR® 88 liners in early 2003, the sloping wall surfaces and valley angles of the transition hoppers were sandblasted to remove the coal and oxide build up. The (8) transition hoppers at the Mirant/Dickerson Plant were then lined with ¾” thick liners and TIVAR® 88 radius profiles (see figure 9). The sloping walls of the auxiliary hoppers below were lined with ½” thick liners.

The liners were prefabricated and shipped to the plant ready to install. Little or no fabrication was required in the field, therefore reducing the installation time. To complete the installation, the lower section of the auxiliary hoppers which had been damaged by years of sledge hammer abuse, to promote coal flow, was replaced with new steel hoppers pre-lined with TIVAR® 88.

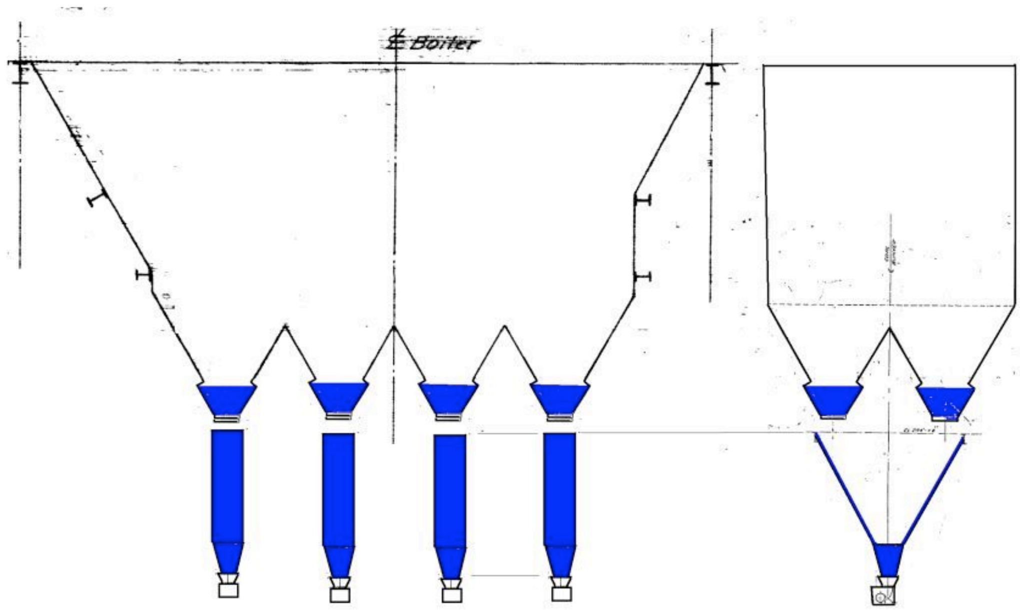

Figure 7: Full bunker arrangement showing location of liners

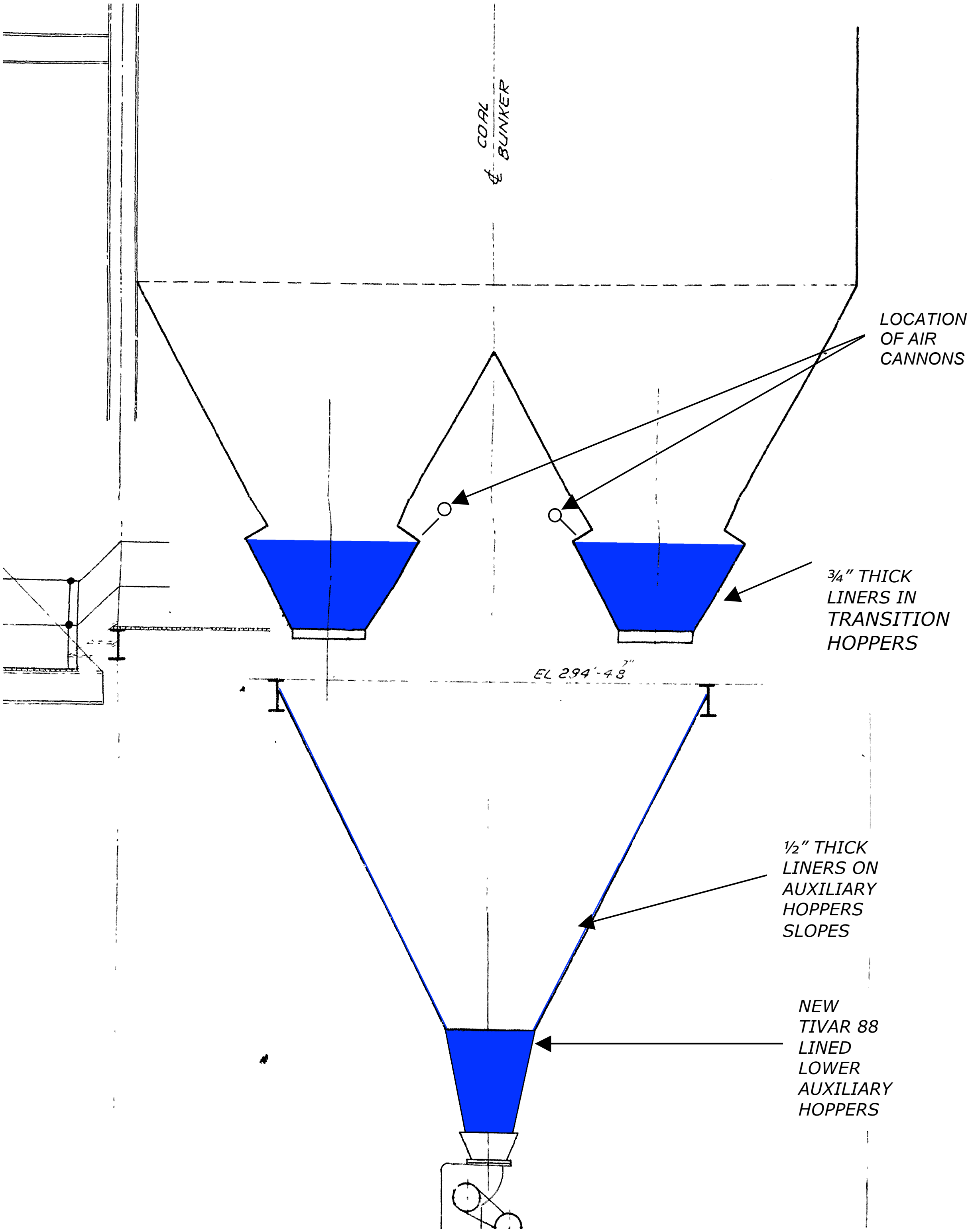

Figure 8: Arrangement of bunkers and hoppers showing location of air cannons and liners

Figure 9: Viewing down into the transition hoppers during installation of TIVAR® liners.

Conclusion

The TIVAR® liners and air cannons have been intact and have performed beyond expectations. The option to install a low coefficient of friction liner accompanied by air cannons was a decision made by Mirant management to avoid extensive and costly bunker modifications that otherwise would have been required to permit coal flow. Since the liners and air cannons have been installed, approximately 9 million tons of coal have been discharged through the transition and auxiliary hoppers without the assistance of plant personnel manually lancing and/or beating on the sides of the hopper to dislodge the coal. The air cannons are periodically fired to clean-out any build-up of the coal in the transition and auxiliary hoppers when the coal bunkers are emptied for unit overhauls. During normal operation, the liners are sufficient to provide coal flow without using air cannons.

An inspection of the liner was performed during an outage in early 2009 and it was noted that the liner showed minimal signs of wear. It is estimated that using the same type and blend of coal at the current discharge rate, the liner may last another 20 years. There was no issue or maintenance required with the air cannons.

The total cost for the installation of air cannons and liners was less than $150,000/unit. Preventing coal pluggage curtailments has permitted each of the three Mirant/Dickerson generating Units to produce and additional 25,000 MW hrs. of electricity per year. The savings incurred is estimated to be $2,500,000 in gross revenues per year. Using the “plastic” liners with the aid of air cannons, generating stations can pay for the improvements in less than a year by eliminating curtailments from loss of coal flow. Payback was achieved in less than 6 months.