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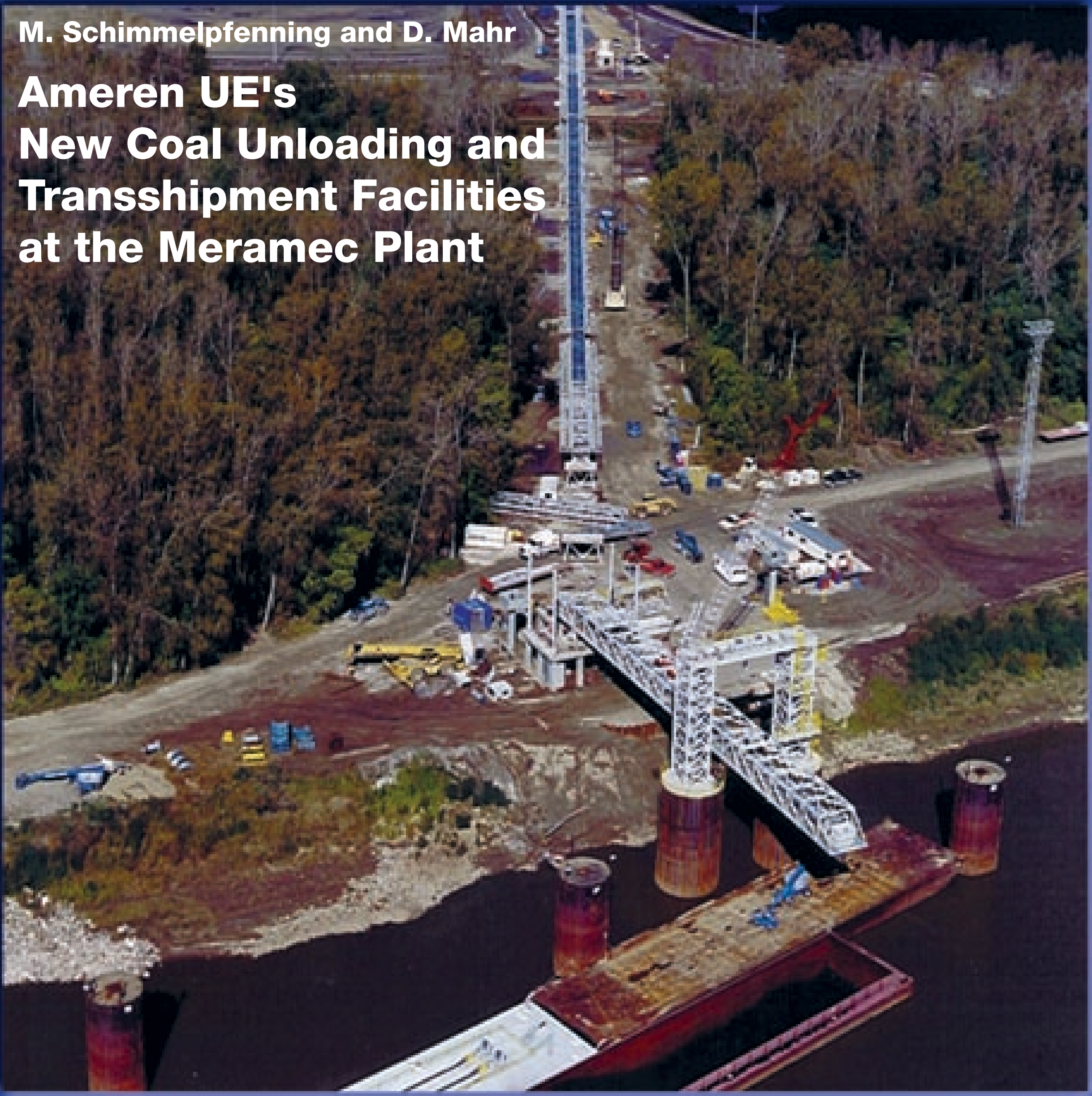

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Ameren UE's New Coal Unloading and Transshipment Facilities at the Meramec Plant

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1. Introduction

PRB coal is America's abundant, cost-effective fuel. Production is increasing at a rate of 20 million t per year. The mine-mouth cost is typically \$0.50 to \$0.60 USD per million Btu (1,05 million kJ). To maximise the savings, transportation from the Great Plains mines to power plants is the primary consideration. An efficient network of unit trains to the Mississippi River and large barge tows navigating inland waterways makes PRB coal a cost-effective option for many states.

The physical proximity of the Meramec Plant, in the heart of America, makes it an ideal location for a rail-to-barge transshipment terminal. The plant is located just south of St. Louis at mile 162 on the Upper Mississippi River, approximately 25 miles below the last lock. Southward, barge navigation is unrestricted by lock dimensions. Large tows dominate the barge traffic, helping to minimise freight rates. To reduce the transportation cost of PRB coal for the Meramec Plant itself and for other utilities who are considering PRB coal, Ameren UE is constructing new coal unloading and transshipment facilities at the plant.

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Details about the authors on page 85.

Fig. 1: The Meramec plant

2. The Meramec Plant

The Meramec Plant, Fig. 1, is a four (4) unit, pulverised coal power plant. The units were commissioned between 1953 and 1961 as shown in Table 1.

The plant historically receives coal by barge. The mainline of the Union Pacific parallels the Mississippi, passing through part of the plant's property. A rail ladder track system and bottom dump rail hopper were constructed at the plant in 1957. This system was later abandoned in-place, and the ladder tracks have now been removed. Illinois mines were originally the primary source of fuel. Barge deliveries, however, allowed the plant to access a wider range of mines to improve fuel options.

During the last few years, the Meramec Plant has experimented with PRB coal. This fuel was used directly and in a variety of blends with Illinois coal. The plant increasingly focused on using 100% PRB coal to minimise both plant generation costs and emissions. With the ever increasing use of PRB coal, the coal bunker hoppers were modified with a mass flow design to avoid stagnating coal that could cause problems. PRB coal is now Meramec's dominant fuel.

Throughout the PRB coal trials and its expanding use, Ameren's coal receiving system remained largely unchanged, the

Table 1: Unit rating and year of commissioning

Unit	Rating. MWe	Commissioned
1	125	1953
2	125	1954
3	250	1958
4	300	1961
Total:	800	

fuel, however, now comes from a different direction. The PRB coal is loaded onto unit trains at the mine in Wyoming. The trains are routed to a barge loading terminal in St. Louis. The PRB coal is loaded onto barges, which shuttle the coal the short distance to the plant. Meramec then unloads the barges at the existing barge unloader. The coal is either stockpiled or directly fueled to Meramec's in-plant bunkers.

3. A Team Effort for a Fast-Track Approach

Ameren examined how coal might be directly transported to Meramec. Energy Associates investigated design options and developed the basic feasibility plan. Other Ameren plants receive PRB coal directly by rail. These plants feature rail loops and large capacity unloading hoppers, which became the model for the system at Meramec.

As part of the design process, Ameren expanded the team with a group of engineering firms, as shown in Table 2. Ameren's own power plant engineering department managed the work and undertook the design of plant related facilities. Design Nine investigated rail options and completed the detail engineering for a loop arrangement. State-of-the-art train capacities are employed - using large, dedicated, 110 t aluminum cars and 135 car length unit trains. Since the rail loop is routed beneath transmission lines in the ash pond areas, line clearances were examined by the Transmission and Distribution Department of Ameren Services. Some lines that cross the loop were elevated, adding supports to obtain the necessary rail clearances. Reitz and Jens examined the geotechnical issues related to the loop track, civil structures, and the accommodations necessary for stabilising the subsurface. The rail and key structures are located in sluiced ash ponds that are layered over soft silty soils, long ago deposited by the Mississippi River. Ameren's civil engineering department designed the rail dumper structure. This is a deep foundation that extends over 60 ft (18.3 m) into the soft silty ash and soil.

Fig. 2: Arial view of Meramec's PRB coal project (photograph by Artega Photos, Ltd.)

Emerson Process Management designed the electrical systems including power supply and distribution, I&C, and lighting. Frucon and Energy Associates designed the remaining foundations. Energy Associates completed the original feasibility study, preliminary engineering designs for project approval, and finally the detail mechanical, structural, site grading engineering and foundation design for the radial stacker and its transfer.

The team concept allowed the project to access a variety of expert assistance, using departments and firms on a timely basis. The feasibility plan and detail designs were continually modified and adjusted as new information was obtained and system features were scrutinised by the members of the project team. The fuel department assessed design features and options - how to provide the flexibility and operating modes that best meet fuel strategies. Meramec Plant personnel tackled operating and maintenance issues, examining design details and equipment selections. Prior to awarding any construction packages, Ameren purchased major mechanical and electrical equipment while the design was still being completed. This helped to assure that long lead items would not delay construction and the detail engineering would accurately reflect equipment and components needed for the project. The direct purchase of this equipment helped to assure that components that were most advantageous were indeed used and that they were purchased at the lowest price possible, directly from the manufacturer.

Table 2: The Meramec's project team

Company	Assignment
Ameren	
Generation Engineering	Project Management/Engineering
Civil/Structural Engineering	Deep pit dumper foundation
Mechanical Engineering	HVAC and utilities
Energy Delivery Technical Services	Raising high voltage lines
Energy Associates	Feasibility study, preliminary engineering, detail mechanical and structural engineering, and radial stacker foundations
Design Nine	Rail loop
Jenike & Johanson	Reclaim feeder design review
Tarlton Corp.	Construction management & General Contractor
Benetech	Dust suppression system
Frucon	Tunnel, transfer/conveyor foundations, and river cells
Interstate Equipment	Work barges
Lewis & Clark	River consulting
McKinney Associates	River consulting
Century Fire Sprinklers	Fire protection

Construction was placed on a fast timetable. Based upon the preliminary engineering design and geotechnical information, detail engineering for the dumper itself was completed and bid nine months ahead of other work. This deep foundation was on the critical path, and an early start was crucial.

With detail design progressing and equipment being purchased, the other construction packages were separately bid including: 1) rail subgrade; 2) finished rail; 3) mechanical and structural erection and foundations; 4) electrical; 5) dust suppression 6) fire protection etc. This approach allowed the project to directly engage individual contractors who have good records on other plant upgrade projects and outage work. It minimised the cost and risks associated with a construction organisation that might require a hierarchy of subcontractors. Tarlton Corporation was the construction manager for much of this work and they were directly responsible for installing mechanical equipment and erecting the structures.

One benefit of the construction approach was the quality of bid data that was given to each contractor. Detail design drawings, equipment supply lists, and even the certified prints and manuals of some equipment were part of the contractor bid documents. This detail information helped to reduce the contractor's risk for quantities and unknowns. He could, for instance, use the structural steel design drawings to obtain firm quotes from steel fabricators.

4. An Atypical Coal Handling System

Meramec's new coal handling system and the transshipment system, as illustrated in Fig. 3, are atypical. While it borrows elements common to high capacity rail unloading systems, it has several unexpected features to entice the engineer who might otherwise be only a casual observer. The project team scrutinised features throughout the design process.

By any measure or standard, this is the largest coal handling system currently being constructed in the U.S. It includes 4,050 ton-miles per hour of conveying capacity. All conveyors are 72 in (1.83 m) wide, rated at 4,000 t/h, and there are over a mile of conveyors. The length of the longest conveyor exceeds 3,000 ft (914 m) . Construction, including the rail loop, barge loader, and plant stacker reach all corners of the plant's property - making the plant itself one large construction site.

4.1 Rail Loop and Hopper

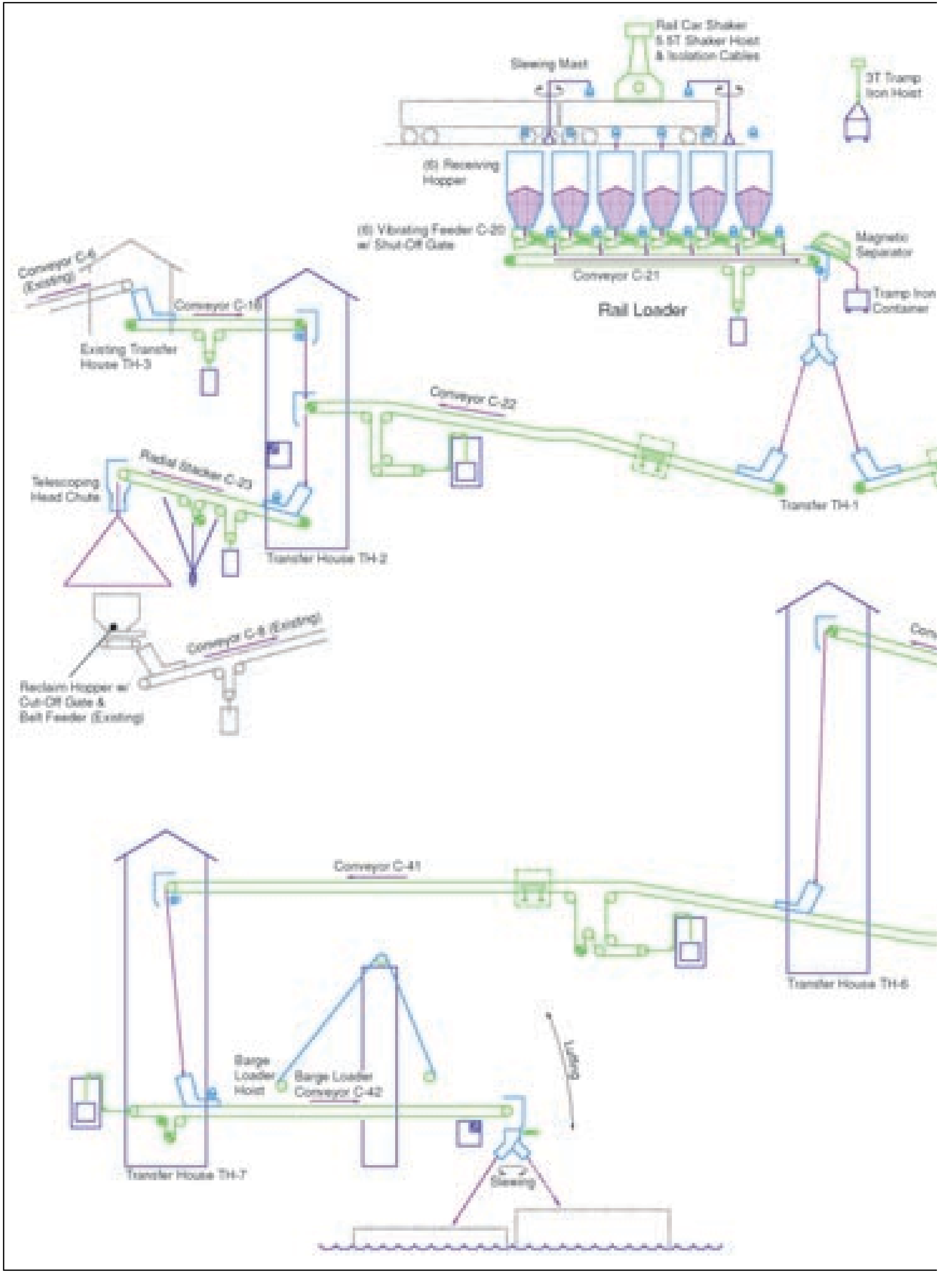
The rail loop circles a large plant area, primarily old ash ponds. Fly ash and bottom ash are layered to depths of 50 ft (15.25 m) over soft silty clays. This is not the best material to support heavy rail loads. A key to supporting the rail was a partial remove-and-replace scheme. Ash was excavated to predetermined depths. The open areas were refilled by first placing a woven geofabric and then refilling with either dried compacted ash or granular fill. The area for the new coal pile was raised using compacted ash and topped with woven geofabric and crushed limestone cover. The pile area is contoured and ditches arranged to direct runoff water to the plant's water treatment system.

Fig. 4: Unloading at the rail hopper

The loop track itself was routed around a number of existing facilities. An access spur begins at the Union Pacific mainline. This spur skirts the existing plant coal pile and an active fly ash pond that itself was recently constructed. This section of the track infringes on part of the west perimeter of the existing coal pile, which is furthest from the plant's existing reclaim hopper. The loop is positioned to avoid transmission line towers, water collection ponds, and a water treatment system. It skirts the plant's main entrance road, close enough to require a low retaining wall and a modest realignment of the roadway.

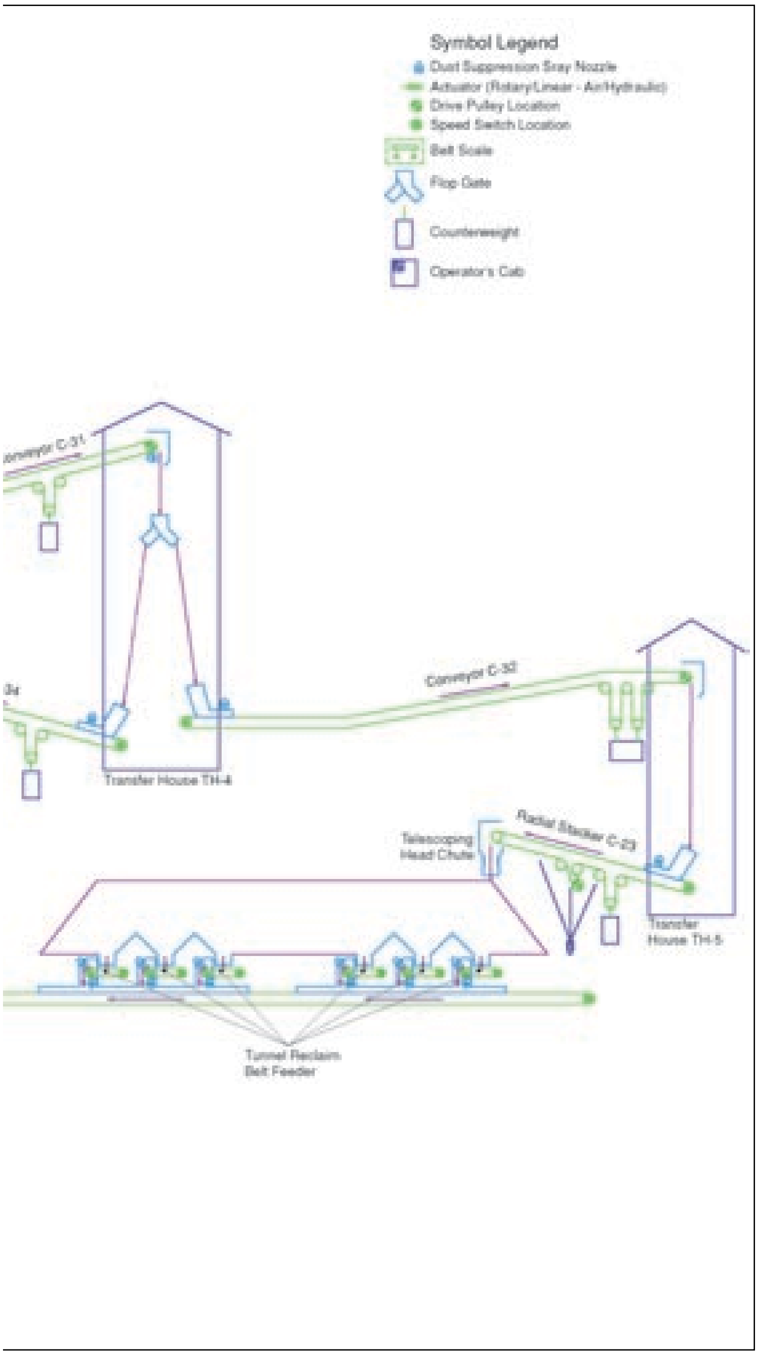
The rail unloading hopper is 1.5 times the length of the cars and nearly four times the capacity of any car. Six 1,000 t/h, vibrating feeders, fitted below the hopper, discharge to a collecting conveyor. The vibrating feeders are variable speed. The operators normally run all six at a reduced rate to achieve the 4,000 t/h unloading rate. This part of the system was directly adopted from Ameren's other plants - a

Fig 3: Flow diagram for the new coal unloading and transshipment facilities



successful design was duplicated. The similarities, however, stop at the discharge to the collecting conveyor.

Collecting conveyor No. C-21 has three features that make it different. Even though this is a relatively short belt, it was fitted with a vertical gravity take-up, which avoids the belt tension uncertainties of screw take-up used at other plants. To prevent downstream tramp iron problems, a self-cleaning magnet is located at the head discharge of conveyor No. C-21. A container, 40 ft (12.2 m) below grade collects tramp iron, and a hoist is used to lift the container above grade for salvage/disposal of the tramp iron. The third feature is a flop gate adjacent to the tramp iron container. This below grade gate directs coal to the Meramec Plant coalyard or the new transshipment system. The below grade flop gate design was chosen to minimise the number of conveyors and provide operating flexibility. Two conveyors exit the rail unloading hopper pit - one routes coal southward to the plant while the other transfers coal northward to the transshipment facilities.



4.2 Stackers

There are not one but two stackers - one for the Meramec Plant and the other for the transshipment distribution terminal. Both stackers are identical. They are huge, seven story machines. It's a hike just to reach the elevated head platform. A fixed height design was elected, which is consistent with the objective to build large, high piles. Each stacker is fitted with a telescopic discharge chute to control windblown dust at the beginning of unloading. The conveyor drive is tucked close to the structure at the rail support leg using a right angle, shaft mounted arrangement. This location for the drive helps to provide traction for the slewing drive while minimising the overhung loads on the structure. A vertical gravity belt take-up is mounted behind the leg, again adding load for wheel traction.

Rugged design features were used for the stacker's structure. The main truss is constructed from steel tube members. These shapes provide an inherently rigid frame that resists torsion and bending in all directions. Fixed legs, supporting the 200 ft (61 m) truss at three locations, converge onto a massive, equalizer box beam. The box beam spreads the supports to a 36 ft (11 m) width, giving the stacker a wide, stable stance.


Fig. 5: The plant stacker unloading a trainload of PRB coal

There are two trucks, one at each end of the equalizer beam. Both trucks have two driven wheels. All wheels are driven to maximise traction under adverse conditions. Single flange wheels with wide rims are used to accommodate the structure's expansion and deflection. The 135 pound rail is mounted on a deep concrete beam, which is supported on pile caps spaced at 36 ft (11 m) centers. The trucks are fitted with double worm gear reducers, vector controlled AC motors, motor brakes, and hydraulic rail clamps. The stacker is secured in storm conditions with a manual lever operated, anchor bar and massive rail stops are located at the travel extremes in case the travel or overtravel switches fail.

The tail of the stacker is supported on a welded turntable. The turntable is secured with a replaceable kingpin and supported on low friction, PTFE plates. While the stacker does not luff, the truss is connected to the turntable with horizontal pins. This avoids introducing any stress into the structure due to deflections or movement. It also assisted the erector in assembling part of the structure at grade level and then hoisting it to its design inclination.

The transfer to the stacker is a cantilevered building. The overhang allows the stacker to swing through a wide arc within the perimeter of the structure. For the plant stacker, a control room is located on the third floor of the transfer. The control room will not only control the new rail unloading operation for the plant system, but all plant coal handling controls are being located here. The room is cantilevered beyond the building, providing a panoramic view from the rail hopper, north of the control room, to the barge unloading area along the southern perimeter of the plant.

Coal can be stacked into two separate piles at each stacker. For the plant, PRB and Illinois coal piles must be segregated. Normally the units will burn PRB fuel. When needed to reach full load, some units are fueled with a blend of Illinois and PRB coal, to increase the heating value, Btu/lb (kJ/kg). The blending methodology for the plant entails a sequence of bulldozer 'pushes' from each pile to the single reclaim hopper. For the transshipment facility, different grades of PRB coal can be stacked for individual plants. These can be separately reclaimed as different fuel consignments, or they can be blended into a precise, custom, recipe, using belt feeders below each pile.

The new plant stacker is arranged so that the existing barge unloader stacking system can be modified in the future to route coal to the new stacker. The new radial stacker can stockpile much larger piles of coal over a wide area. Routing barge coal to this machine will reduce the amount of bulldozing than would otherwise be required.

4.3 Reclaim Feeders

The plant system reclaims coal using an existing hopper and belt feeder. Due to the proximity to structures in the coal yard, a low retaining wall was enlarged so that more coal could be stacked and bulldozed directly over the hopper. This belt feeder reclaims at 800 t/h, for the plant system.

The reclaim feeders for the transshipment system consist of two groups of three, ganged feeders. The inlet openings of the feeders are 'connected' by canopy structures. This creates a reclaim arrangement that is much like having a bin with three outlet hoppers. The steeply sloped canopies between the feeders functionally connect the feeder inlets for flow purposes. Instead of having a 6 ft (1.83 m) long opening for a single feeder, the three feeders and canopies provide a 42.5 ft (12.96 m) long 'slot' for coal flow. This is a rather wide-mouth opening for the reclaim funnel, which will reduce the possibility of bridging, ratholes, or other flow problems. The objective is to minimise flow problems that could hamper the 4,000 t/h reclaim system.

The belt feeder canopies, inlet hoppers, and feeder skirtboard design were reviewed by Jenike & Johanson, a consulting firm that specialises in bulk material flow properties. They had previously tested a number of PRB coals from different mines for the in-plant bunker upgrade. Their recommendations on slopes and geometry were directly adopted in the design.

Each feeder is a 60 in (1.52 m) wide belt operating at 200 ft/min (1.02 m/s). This is double the speed that used for most conventional belt feeders and four times (4x) the speed employed by the vibrating feeders. A high speed design was selected to minimise the size and number of belt feeders. Some coal handling installations are constructed without feeders, either using gates to control flow or the reclaim belt conveyor itself as an extremely high-speed feeder, usually with only a small head of coal. Gates are more difficult to control and depend upon adjusting the opening for flow rate control. A partially open gate would reduce the effectiveness of the canopies and the objective of creating a wide-mouth reclaim funnel. The arrangement for the transshipment facility extends belt feeder technology, combining features to maintain high capacity control and flow. The feeder belts themselves have extra heavy, high grade rubber covers to maximise belt life.

Fig. 6: Canopies being constructed at the reclaim belt feeders

4.4 Barge Loading

Barges are loaded at 4,000 t/h using just two conveyors. A single, 3,000 ft (915 m) long conveyor No. C-41 collects the discharge of the reclaim belt feeders and hauls the coal to the bank of the Mississippi River. A 185 ft (56.4 m) long boom conveyor No. C-42 then loads the barges.

For most coal handling systems, the length of conveyor No. C-41 is rather long. There are, however, numerous overland conveyors whose lengths are measured in miles. These will typically link mines to plants or ports. What perhaps distinguishes the transshipment facility's loading conveyor is its capacity and the fact that it does not run at grade level. Most overland conveyors are rated perhaps 1,000 to as much as 2,000 t/h, as required to meet mine production or processing levels. A long, 4,000 t/h conveyor is rather unusual. A grade level conveyor is the most economical design. That design was not practical for this system. Conveyor No. C-41 runs either underground, in a tunnel, or is elevated above grade in box span trusses and galleries. The above grade section has three rail crossings, dips beneath high voltage transmission lines, spans plant roads/pipes, and extends above a portion of property subject to seasonal flooding by the Mississippi River. Intermediate access to the overhead structure is provided with periodic ladders and a stair tower.

Two features on the transshipment system will help to maximise production. A pant leg chute with a gate is fitted to the end of the barge loading boom. The loader can switch on-the-fly from one

Fig. 7: Elevated section of the 4000 t/h, 3000 ft (915 m) long barge loading conveyor being constructed

Fig. 8: Barge loader under construction

barge to the next. Normally, a string of three barges will be handled by the barge haul while the harbor tug retrieves the next string for loading. When loading must be interrupted, a scoop tube fluid drive allows the conveyor to stop fully loaded while the 700 hp (522 kW) motor runs in an unloaded condition. Large motors do not tolerate periodic stops very well. Stopping the conveyor while loaded is important, this 3000 ft (915 m) long conveyor takes about four (4) minutes to empty and likewise four (4) minutes to 'fill'. The fluid drive also enables the conveyor to slow, so the operator can more easily 'trim' the barge.

The 185 ft (56.4 m) long barge loading boom has several operating/service features that make it a little unique. The length of the boom positions its tail on the shore transfer. The first floor of the transfer is 14 ft (4.27 m) above grade, to be above the flood level of the Mississippi River. While the boom itself luffs, the conveyor drive and gravity take-up do not; they are mounted on the first floor of the shore transfer, much like other conveyor drives for the system. This provides convenient access for maintenance. A valve house is also mounted on the first floor. The second floor of this structure supports the discharge of C41 and a transformer. The third floor supports an electrical room.

The boom hoist is mounted atop the boom gallery, directly adjacent to the transfer. This position for the hoist makes it accessible while using the hoist's rope pull to partly offset the structural loads experienced by the boom.

Access at the loader allows operators and deckhands to reach the loading area from shore, via a series of stairs and walkways. The boom itself has 'doorways' that provide access from platforms external to the boom to walkways within the boom truss. The operator cab is located beneath the boom, directly above the work barge. The cab operator has a direct view of the pant leg chute and loading operation. Access from the boom to the cab is via an external staircase, which is part of the pinned support platform for the cab. Access to the work barge is via a stair tower on the barge, which is adjacent to the operator cab platform. A small 'drawbridge' is lowered to connect the two.

5. Operating Modes

During the preliminary design phase of the project, the team scrutinised every aspect of the system. It was assessed from a variety of perspectives. As a result, the system features a number of service modes, providing flexibility and operating options.

All chute gates are designed as splitter gates, except the one in the dumper.

The transshipment system is equipped with a stockpile bypass conveyor. If part of the stacking or reclaim portions of the system are down for maintenance, receipts can be directly routed from the rail hoppers to barges without ever being stockpiled. This can be advantageous for single spot consignments, where ground storage might complicate the transaction. Conversely, if ground storage is not an issue, the system can 'untie' rail unloading from barge loading. The transshipment's stacker can be positioned directly over the reclaim belt feeders so that coal can be simultaneously stacked and reclaimed. In this instance, the pile directly over the reclaim hoppers provides surge capacity. Any interruption in one operation does not immediately affect the other. Barge loading can temporarily stop to switch strings of barges while rail unloading continues unabated.

The transshipment system can blend coal. The two groups of belt feeders in the reclaim tunnel can be set to reclaim different coals at predetermined ratios for a customised blend. A belt scale between the feeders is used to calibrate the blend on a measured weight basis. It is also possible to sweeten blends using the rail hopper. In this case, an additive can be dumped in the rail hopper and layered onto the coal reclaimed by one or both groups of reclaim belt feeders. The transshipment's receiving scale would monitor and control the additive.

6. Start-up

Commissioning is sequenced to receive PRB coal and feed it to Meramec Plant first. Construction for the coal handling package began in January, 2001. The plant system was commissioned first, with the first trainload of coal unloaded on September 24, 2001 and the system turned-over to the plant on October 15th. Meanwhile, construction on the transshipment system continues and will be commissioned at the end of January, 2002.

Meramec's new coal handling facilities are helping Ameren to best utilise PRB coal, and the new transshipment facility will allow other businesses to take advantage of this cost-effective fuel.

Fig. 9: Arial view of the transshipment barge unloaderbelt feeders (photograph by Artega Photos, Ltd.)