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Analysis of Brokerage Feasibility for Unit-Coal-Train Shipments to the Midwest

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The purpose of this paper is to determine the feasibility of aggregating industrial and utility demands for coal and of serving the demands through a local brokerage operation to reduce transportation cost. This cost saving is associated with the economy of scale of unit-train shipments. The delivered price of western coal is calculated for local users in a given Midwest subregion based on current utility and industrial coal demands. The broker operation would consist of unit-train hauls from western mines, a receiving and storage terminal, local truck or rail transportation from the terminal to each user, and possible transshipment to distant waterfront users. The research focuses on the area of Green Bay-Kewaunee in Wisconsin. Applicability of this brokerage concept to other areas that receive western coal shipments is also discussed.

In order to decrease U.S. dependence on foreign energy products used by utilities and industries, the Carter Administration has mandated an increase in the share of coal-fired industrial and utility boilers. This will create the need for more coal that is capable of meeting clean-air standards. Western mines are the obvious source due to the plentiful amount of low-sulfur coals. These mines have entered into long-term contracts with many large utilities (1). These long-term commitments allow for reduced cost of delivery of the coal, largely due to the use of unit trains. Users of small amounts are unable to capture these reduced costs because of their low-volume shipments. As more utilities want to convert to western coal and as industrial coal-fired boilers become more prevalent, alternative distribution methods may be required to make coal a more cost-effective energy alternative for these users.

The objective of this paper is to present a concept called coal brokerage, by which the coal demand of an area is aggregated and served through a single facility in order to achieve the high volumes necessary to justify unit-train service. Once such a system is initiated, it is conjectured that those users whose orders are too small to receive unit trains individually can begin to capture the cost savings associated with unit-train service.

In order to analyze the coal-brokerage concept, the region of Green Bay-Kewaunee in Wisconsin was chosen as the site for analysis because (a) there had been speculation by lower-peninsula Michigan utilities about a Wisconsin transshipment site for western coal, (b) the area's paper industry uses a large amount of coal, (c) the Wisconsin Energy Office has researched coal consumption in depth and has an available data base for industrial boilers and their fuel type, (d) line-haul rail routes allow for adequate access from western mines to utility and industrial coal users, and (e) there is no single user or facility currently large enough to handle unit-train shipments.

In this paper, the existing geographical traits of the Green Bay-Kewaunee region, including the local transportation network, are detailed. Alternative brokerage setups and operational strategies are discussed. Total coal demand necessary to substantiate a brokerage and transshipment site is estimated. A detailed description of the current prices of line-haul rail, terminal and transshipment, and local distribution is given in order to calculate the total cost of coal to the subscribers of a brokerage operation, and these figures are compared with current local coal prices. Finally, the advantages and disadvantages of the brokerage concept are outlined, and their application to other sites and to bulk commodities is summarized.

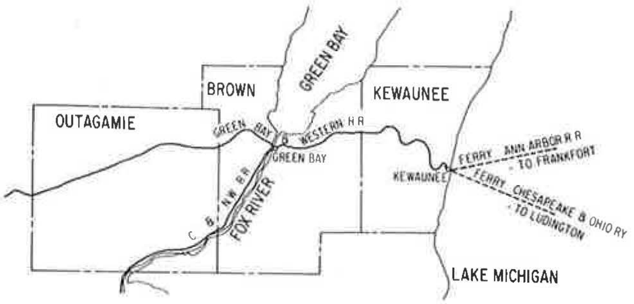
SITE DESCRIPTION

The Green Bay-Kewaunee region is in northeastern Wisconsin and includes Outagamie, Brown, and Kewaunee counties. The area is delimited by Lake Michigan, Green Bay, and the Fox River, as shown in Figure 1. The Fox River is navigable only six miles upriver from the bay, where the port facilities and major industries are located. The industry in Green Bay primarily revolves around paper products. The paper and pulp mills are located along the riverfront due to their needs for coal shipments and for water. No significant industry is located in Kewaunee.

The industry of the area is relatively stable; no major growth trends are evident. No riverfront land is readily available for new industries, and the navigation aspects of the river channel restrict the use of larger vessels now under construction. However, a vacant industrial area along the bay not far from the river, called Bayport, is available for new industry and is the most likely location for a coal-brokerage terminal. The present industrial area has been declared an environmental nonattainment area, which means that air-pollution levels may force any new industries to locate farther away from the present industrial core.

Northeastern Wisconsin's transportation system consists of three railroad companies, adequate highways and streets, and port facilities for Great Lakes shipping. The Chicago and North Western

Figure 1. Green Bay-Kewaunee region.



Transportation Company (CNW) and the Chicago, Milwaukee, St. Paul, and Pacific Railroad Company are major railroads serving Green Bay. The Green Bay and Western Railroad Company (GBW) serves points west to the Mississippi River, where it connects with the Burlington Northern, and a transshipment point at Kewaunee to the east. Figure 1 shows the rail lines that would play a role in increased coal traffic. Potential problems of increased coal traffic are (a) greater use of an old GBW bridge over the Fox River that is regularly out of service, (b) the need for heavier rail on the GBW main line, and (c) increased rail traffic in certain residential areas. These problems can be resolved by rerouting and investment.

Green Bay is served by highways that link it with Fox River Valley cities, points along the Lake Michigan shoreline, including Kewaunee, and the upper peninsula of Michigan. Three highways form a divided-highway belt around the city. The street system is a basic grid adapted to the Fox River; adequate arterials through main corridors serve the industrial areas well.

Kewaunee and Green Bay both serve as Great Lakes ports, and each offers potential advantages as coal-transshipment points. The port of Kewaunee is capable of year-round operations and offers a more-direct route to Michigan utilities than does Green Bay. The port and its surrounding area have an acreage constraint that affects coal storage and track layout due to the Kewaunee River wetlands, which are protected by the Wisconsin Department of Natural Resources, and steep bluffs that rise to 50 ft. The Green Bay area has an adequate transshipment site (Bayport), which has ample available land for a coal terminal. The port of Green Bay is planning to build an L-shaped peninsula into the bay to serve larger ships now unable to navigate the Fox River, but environmental questions about impacts on the bay and nearby wetlands have been raised. A disadvantage of a Green Bay site is that the port is closed for three to four months of the year due to ice conditions.

THE COAL BROKERAGE

The coal-brokerage concept focuses on aggregating user demands and on using high-volume transportation and handling to meet those demands. The concept of consolidating bulk commodity shipping is not new, but its application to coal delivery is uncommon. In agriculture, terminals collect grain from farms for transfer onto rail or barge. In the eastern coal industry, individual carloads of coal from area mines are collected to form unit trains. The coal-brokerage concept differs in that coal from one source is distributed to several users, as opposed to the collection of commodities from several points and their transportation to one user. The high output of western coal mines allows the use of one source.

The coal-brokerage operation centers on a bulk-handling facility. A terminal is necessary for receiving high-volume line-haul shipments, for storing these shipments, and for distributing them to local users. Storage is necessary to smooth out the disparity between batch arrival and continuous use of coal. Therefore the operation consists of (a) high-volume transportation from the mine, (b) a receiving and storage terminal, and (c) transportation from the terminal to the user.

Terminals may be arranged in a variety of ways depending on site advantages and constraints. A train-unloading system is necessary; this can be done by bottom dumping, in which hopper cars are emptied from the bottom into a coal pit beneath the track, or by rotary dumping, in which cars are individually turned over and the coal is dumped into a bin. A track layout that minimizes switching and uncoupling is most efficient, but land constraints may require a less-favorable layout. A track loop is preferred to parallel holding tracks because of its continuous operating capabilities. A stacking and reclaiming system is needed to move coal from the dumping area onto a stockpile (stacking) and to remove it from the stockpile (reclaiming). These tasks can be accomplished by a single stacker-reclaimer, which both dumps and removes coal from the top of the stockpile, or by a system that dumps coal from the top and reclaims it from tunnels beneath the stockpile. Last, equipment is needed for transfer to other modes; such equipment as stationary shovelers or mobile front-end loaders are needed for trucks, and rail cars and dock-mounted ship loaders are needed for transshipment. Conveyor belts typically connect the unloading, stacking-reclaiming, and loading systems.

BROKERAGE ALTERNATIVES

The relative advantages and disadvantages of brokerage sites at Kewaunee and Green Bay, as well as their potential as transshipment sites, created the need for various brokerage alternatives. Each alternative is a type of operation and terminal setup that could conceivably serve coal demand by using the brokerage concept.

The first alternative consists of a major bulk terminal at the Bayport site in Green Bay. Unit-train coal would be stockpiled and distributed locally by rail or truck and also loaded onto lake vessels for delivery to lower-peninsula utilities. Advantages of a Green Bay site include nearness to users (many within a 3-mile radius) and plentiful land for efficient train unloading and stockpiling. A disadvantage includes the suspension of transshipment during the winter months, which requires stockpiling by the Michigan users.

Another alternative is to send a portion of unit trains to a Kewaunee facility. This would exploit the advantages of year-round shipping from Kewaunee. For example, unit-train deliveries might alternate between Kewaunee and Green Bay. The second alternative would therefore include building two smaller terminals. The Green Bay site would receive, store, and distribute coal as before, but without transshipment. The Kewaunee site would receive, store, and transship the coal to Michigan utilities. Disadvantages include the loss of scale economies from the use of two smaller terminals and limited land for storage at the Kewaunee site.

A third alternative is a modification of the second and addresses the storage problem at Kewaunee. The need for storage can be eliminated if coal is loaded directly onto a vessel from the unit

Table 1. Projected coal demand of industries and utilities.

Site	Coal Tonnage (000 000s) Base Year 1978	Projected Year 1980	1985	2000
Wisconsin				
Green Bay industries	810	810	810	810
Pulliam utility	767	767	767	767
Michigan				
Muskegon utility	1366	3308	3308	3308
West Olive utility	1416	1416	1416	1416
Holland utility	146	146	146	146
Grand Haven utility	0	0	212	212
Total	4505	6647	6659	6659

Note: Data are from Asbury and others (1) and Wisconsin Energy Office.

Table 2. Estimated costs of western coal for three alternative locations.

Item	Cost by Location ($/ton) Green Bay	Green Bay-Kewaunee	Green Bay-Kewaunee (no storage)
Component costs			
FOB mine	11.00	11.00	11.00
Unit train	10.00-14.00	10.00-14.00	10.00-14.00
Brokerage facility			
Green Bay	1.50-2.25	1.50-2.25	1.50-2.25
Kewaunee		1.50-2.25	0.50-0.85
Great Lakes shipping			
Green Bay-Michigan	1.11		
Kewaunee-Michigan		0.63	0.63
Local distribution			
Rail	1.68-2.84	1.68-2.84	1.68-2.84
Truck	1.00-1.50	1.00-2.50	1.00-2.50
Delivered price			
Wisconsin by local rail	24.18-30.09	24.18-30.09	24.18-30.09
Wisconsin by local truck	23.50-28.75	23.50-28.75	23.50-28.75
Pulliam	22.50-27.25	22.50-27.25	22.50-27.25
Michigan	23.61-28.36	23.13-27.88	22.13-26.48

train. Less equipment and less land are needed in this setup. A disadvantage is the requirement of accurate timing between rail and vessel arrivals.

Other alternatives were considered but rejected for various reasons. A single central facility in Kewaunee was rejected because of the storage problem and because of the 35-mile westward backtrack from Kewaunee to the Green Bay users. The distance is not economically wise for a large-volume trucking operation and could cause serious local roadway maintenance and environmental problems. Another idea was to have the unit train drop off a specified number of full hopper cars in Green Bay on its way to Kewaunee. The cars would be distributed locally without the need for a terminal facility in Green Bay while the rest of the train was unloaded at a Kewaunee facility. The major problem here is that unit-train rates would not apply due to the breaking of the train.

UTILITY AND INDUSTRIAL COAL USE

The utilities in Wisconsin and Michigan that will be most likely to benefit from any new western coal distribution from the Green Bay-Kewaunee area are Pulliam in Wisconsin and Muskegon, West Olive, Holland, and a new power plant to be sited in Grand Haven on Michigan's lower peninsula. Demand data for 1972-1978 use of coal by utilities and data obtained by telephone on the new power plant formed the basis of an estimation of base-year and projected coal use for each utility site (1). The data consist of a listing of all coal-using utilities, their sources of coal, the type of haul, and coal heat content, sulfur emissions, and price.

Wisconsin utility coal demand was studied at the Pulliam plant in Green Bay. Coal demand was relatively constant throughout the 1972-1978 period. No new boilers have come on line, and it is expected that this will be the case in the future due to the stable nature of the area's economy. Table 1 shows the present demand at the Pulliam plant and the projected demand based on no new boilers or increase in coal demand.

The present and projected coal-tonnage requirements for the Michigan plants are also shown in Table 1, in which growth is seen only at the Muskegon site, where additional facilities are under construction. The new Grand Haven power plant is scheduled to be operational by 1982.

Projected industrial coal use in Green Bay shown in Table 1 is about 810 000 tons/year based on Wisconsin Energy Office data. The industrial coal demand, generated largely by paper and pulp mills, is projected to remain constant.

Boiler conversions from oil and natural gas to coal may occur as a result of price decontrol for these fuels. Location will play a role in the extent of conversions due to the designation of the industrial core as a nonattainment area. Users that are potentially the strongest candidates for conversions will not alter the aggregate industrial demand substantially.

COST ANALYSIS

Brokerage Cost Components

An important aspect of brokerage feasibility is its cost competitiveness with present coal-delivery operations. If the delivered price of western coal to users via a broker is not competitive with present prices, the brokerage will not be economically feasible. A way of deriving the delivered price is to identify the cost of each component for a mine-to-user journey. Such components include freight-on-board (FOB) mine costs, unit-train rates, brokerage-facility costs, local-distribution costs, and Great Lakes shipping costs for Michigan users. Estimates of these costs by the alternatives are shown in Table 2; they were obtained by surveying similar current operations.

FOB mine cost is the price charged for mining coal and loading it onto a rail car. This price is primarily dependent on the type of mine and the amount of coal purchased. Since our interest centers on western coal, the FOB mine cost shown is for the Decker Mines of Montana and assumes the purchase of 4 000 000 tons/year (2). The total demands of Green Bay utilities and industry and of eastern Lake Michigan utilities are likely to exceed this amount.

Unit-train rates are dependent on distance traveled and annual tonnage. It is difficult to obtain a point estimate for a given distance and tonnage, so rate ranges are shown in Table 2. These data apply to a 1031-mile Decker-Superior route and are used due to geographical similarities to a Decker-Green Bay route (2). The latter route is roughly 100 miles longer and is not likely to affect this rate range significantly.

Handling costs at the brokerage facility depend on the capacity and capabilities of the terminal. The transshipment cost of $1.50/ton shown in Table 2 has been confirmed by a coal-terminal engineering firm as an industry standard (according to J. Norwood of Dravo Corporation) for a facility of medium to high capacity (10 000 000 tons/year or

Table 3. Price of coal delivered to Wisconsin and Michigan utilities.

Utility Site	Current Price[a]	Estimated Delivered Price ($/1 000 000 Btus) Green Bay	Green Bay-Kewaunee	Green Bay-Kewaunee (no storage)
Wisconsin				
Pulliam	1.22-1.33	1.17-1.42	1.17-1.42	1.17-1.42
Michigan				
Muskegon	0.98-1.35	1.23-1.48	1.20-1.45	1.15-1.38
West Olive	1.15-1.64	1.23-1.48	1.20-1.45	1.15-1.38
Holland	1.69	1.23-1.48	1.20-1.45	1.15-1.38

[a]Assumes 12 000 Btu/lb.

Table 4. Price of coal delivered to Green Bay industries.

Amount Used per Year (tons 000s)	Current Price[a]	Estimated Delivered Price ($/1 000 000 Btus) Green Bay	Green Bay-Kewaunee	Green Bay-Kewaunee (no storage)
0-50	1.87-2.08	1.22-1.56	1.22-1.56	1.22-1.56
51-100	1.66-1.87	1.22-1.56	1.22-1.56	1.22-1.56

[a]Assumes 12 000 Btu/lb.

more) that has rail-dumping, storage, and ship-loading capabilities (2). Such a facility would be required for the first alternative, in which the brokerage operation would be located in Green Bay. The second alternative requires two smaller terminals, and the throughput cost rises as expected. A $1.95/ton price is interpolated from estimates of $1.50 for a 10 000 000-ton/year facility and $2.25/ton for a 2 000 000-ton/year facility, assuming the need for a 5 000 000-ton/year facility at each site (according to J. Norwood, Dravo Corporation). A range of $0.50-0.85/ton for direct rail-to-water transfer without storage capability is shown under the third alternative. The price of $0.85/ton was quoted by an Illinois mining company (according to G. Roberts, Freeman United Coal Company) and by a New York utility (according to D. Vrooman, Niagara Mohawk Power Corporation).

Transshipment of coal to Michigan utilities involves a Great Lakes shipment from the brokerage site. The figures in Table 2 assume $0.006/ton-mile for an average trip length of 105 miles from Kewaunee to Michigan and 185 miles from Green Bay to Michigan (2,3). The Michigan utilities considered are on lakefront sites, and the assumption is made that there is no need for local truck or rail transfer. The cost of unloading is assumed to be included in the Great Lakes shipping costs.

Local rail and trucking prices were obtained from conversations with local railroads and paper companies, since such rates are site specific. The tariff ranges from $1.68/ton for a local switch by the GBW to $2.84/ton for a 20-mile shipment between Green Bay and Kimberly, Wisconsin, by the CNW (ICC tariff 17104-C, item 234; ICC tariff 6639, item 570). The two rates thus set a range for local rail distribution. The local truck-haul rate paid is $1.00/ton for a truck haul of 2-3 miles (according to C. Prince of Proctor and Gamble Company).

Cost Comparison

The delivered prices for the various delivery modes and destinations are obtained by adding the appropriate price components. For example, the delivered price to Green Bay by rail (Table 2, Wisconsin by local rail) is the sum of FOB-mine, unit-train, Green Bay brokerage-facility, and local-rail costs, while the delivered price to Michigan utilities is the sum of FOB-mine, unit-train, Kewaunee or Green Bay brokerage-facility, and Great Lakes shipping costs. The Pulliam price is a special case; the utility's location next to the brokerage site decreases or eliminates local distribution costs.

Before a comparison of present prices and estimated broker prices can be made, a conversion is necessary. Eastern and western coals differ in their heat content, so examining prices paid per ton of coal is not an accurate way to compare prices paid for energy. The estimated delivered prices from Table 2 have been converted to dollars per million British thermal units; a heat content of 9600 Btu/lb for Decker coal was assumed (2). These prices and the current prices paid by Wisconsin and Michigan utilities and Green Bay industries are shown in Tables 3 and 4 (1); the current prices were obtained by assuming 12 000 Btu/lb for the eastern and midwestern coal now used.

In a comparison between prices and estimated broker prices, several observations can be made. Broker prices to the Pulliam generating plant in Green Bay are within the range of prices now paid (Table 3). This means that western coal prices via a broker do not offer substantial cost savings for the plant but are competitive. However, it would cost more than the current price for the Michigan utilities to obtain western coal through a Wisconsin terminal (Table 3).

It is understandable that brokered coal does not offer substantial cost savings to utilities because the volumes of coal used are relatively high and have already enabled high-volume purchases and forms of delivery. However, industrial users are more likely to realize cost savings from a brokerage due to the higher purchase and transportation prices paid for lower volumes of coal. For example, the Pulliam plant pays $30-35/ton for eastern coal, whereas Green Bay industries that use less than 50 000 tons/year pay $45-50/ton. Table 4 shows that a coal brokerage would indeed provide substantial cost savings to Green Bay industries. The magnitude of possible savings can be illustrated by the fact that a saving of $0.50/1 000 000 Btu for a plant now burning 50 000 tons of eastern coal per year will result in a total saving of $600 000/year.

FINDINGS

A cost analysis of brokerage alternatives shows that western coal via a broker can offer significant savings for the Green Bay industrial users. Prices of brokered coal are competitive with prices now paid at the Pulliam plant in Green Bay; however, the brokerage coal does not seem to be cost competitive for Michigan utilities.

The Michigan utility demands make up a significant portion of the total demand (Table 1) and are important in supporting the volume assumed in the cost analysis. Therefore, the feasibility of a brokerage in this area appears to be contingent on a decision by Michigan utilities whether to use western coal despite the price disadvantage.

Air-quality standards play a large role in the decision and will favor western coal if they are not relaxed. It is likely that Michigan utilities may favor western coal due to its slower price escalation, since eastern coal prices have risen faster than western coal prices due to labor demands

and mining techniques. These factors suggest that western-coal use on the lower peninsula of Michigan may well become widespread enough to justify the volumes assumed in this study.

Other issues and assumptions underlie the above conclusions of this study: (a) Demand projections have been based on present stringent air-quality standards; (b) it has been assumed that all coal users are capable of using western coal; (c) infrastructure issues affect the feasibility of a brokerage and have not been addressed (e.g., the owner or operator of a brokerage could be a utility, coal company, shipping company, or railroad company, which could affect the type of operation, location, and prices charged); and (d) pricing policies, such as pricing based on quantity purchased, have not been examined.

FURTHER CONSIDERATIONS

The criteria for evaluating the feasibility of a coal-delivery system, such as the brokerage operation, include more than the delivered prices per unit of coal. Environmental, economic, land-use, and regulatory considerations also need to be explored.

By allowing for unit-train movement, western low-sulfur coal can be made available to users of small amounts. Depending on federal policy, the use of low-sulfur coal can be an alternative to large investments in high-cost scrubbing equipment. By burning the low-sulfur coal, government-imposed air-quality standards are more easily met, which possibly could increase coal use even in nonattainment areas.

The broker-terminal operation simplifies the process of contracting for coal supplies for certain firms (particularly utilities). Rather than contract volumes and rates separately with the mine, the railroad or line-haul mode, and the intermodal facilities, the firm need only deal with the brokerage representative, who will have made these separate contracts as part of the operation and include them in the single rate negotiated and agreed on.

Since all coal users will be served by a local high-volume broker, there is less need for individual firms to stockpile coal at their respective plant sites. The single local storage location of coal would allow local plants to use land currently set aside for on-site coal storage more productively. In those regions where land rents are high or the availability of vacant land is restricted, this can allow a firm to expand its plant without being hampered by local land constraints.

There are some disadvantages to aggregating the demands of a number of relatively low-volume coal users and serving them through a single broker. In order to justify unit-train service and for the terminal to receive and locally distribute the coal, some commitments must be made by large-volume users to ensure that minimum volumes can be achieved. Without such support, the establishment of a broker operation is too risky an investment. Low-volume users, on the other hand, may not be willing to commit themselves to one source of coal; they may prefer instead to buy coal on the spot market in hopes of purchasing it at the lowest current rates.

To achieve the necessary volumes for cost savings, one coal broker should be the sole distributor to a region. The local supply of coal to the region's industries and utilities will be tied closely to the operation of the broker system. If any component fails or closes down for any number of reasons (equipment breakdowns, weather, strikes, etc.), the local economy may be affected. The lack of any individual-firm storage of coal, although it means that the land can be put to more-productive uses, also means that coal supply is tied directly to the smooth operation of the brokerage. Service interrupted for even a day could conceivably lead to a disruption of plant operation. Measures must be taken to ensure that such a relationship does not exist and that the local economy will be protected from short-term interruptions.

Depending on the organizational infrastructure of the brokerage, a monopoly or cartel on coal for the subregion results. Although the economies of scale and their resulting cost savings are achieved, small-volume local users may not be able to achieve a corresponding price reduction if the broker decides to price as a monopolist and maximize the profits.

The brokerage concept is applicable to other regions and commodities as well. An area with a total coal demand that is high enough to justify unit-train delivery can be considered a candidate for a brokerage operation. Other necessary attributes include adequate rail access to western coal mines, moderate concentration of coal users to minimize distribution costs, adequate roadway or rail access to local users, adequate land for coal storage, and minimal environmental impacts of site development. Access to waterborne transportation is desirable because the ability to serve distant coal users on waterfront sites will increase the volume handled and enable further cost reductions associated with such higher volumes. A brokerage can also serve other commodities as long as an area's transportation, location, and demand attributes are similar to those mentioned above.

A trend is developing in new terminals that indicates potential growth of the brokerage concept. New terminals are being designed for several users or commodities or both. For example, the Hall Street Coal Terminal in St. Louis was designed to use excess handling capacity for customers other than its primary customer and is capable of storing several types of coal separately. Also, Detroit Edison is seeking coal customers to buy excess capacity at its new Lake Superior terminal. The emergence of such multiuser bulk-terminal facilities indicates a growing interest in exploiting the scale advantages of large shipments and terminals.

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