5. ASSESSMENT RECOMMENDATIONS

AR No. 1

Improve Power Factor

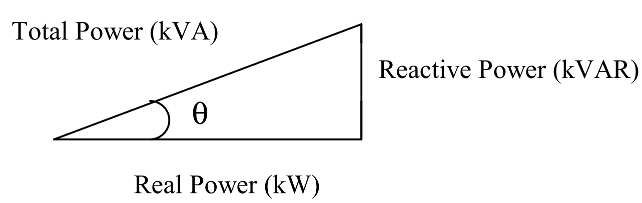
Recommended Action

Power factor penalties account for 11% of your annual electricity cost. Installing 2,500 kVAR of capacitance to correct for low power factor will reduce power factor penalties approximately 82%.

Assessment Recommendation Summary			
Energy (10^6Btu)	Cost Savings	Implementation Cost	Payback (years)
0	$76,739	$50,000	0.8

Background

The total power is made up of two parts: the real power and the reactive power. The real power does the useful work and is measured in kilowatts (kW). Reactive power is measured in kilovolt-Amperes Reactive (kVAR). It is the power needed to excite the magnetic field of an induction motor or other inductive load. The two parts are vector quantities that add up to make the total power, measured in kilovolt-Amperes (kVA).



The reactive power component does no useful work, and is not registered on a real power meter. However, it does contribute to the heating of generators, transformers, wiring, and transmission lines. Thus, it constitutes an energy loss.

Your company is charged by the amount of total power you receive from the utility. Since you cannot reduce the amount of real power you use the only way to reduce the amount of total power you receive from your utility is to reduce reactive power use.

Anticipated Savings

Since you paid for 1,800 kVAR of capacitance that was added to your utility company's distribution system, you are only billed for 75% (%TP) of the actual kVA that you use. This percentage of the actual kVA is billed as the monthly power charge (PC) at a rate of $4.75 per kVA.

The following Power Factor Correction worksheet shows the effect of adding various amounts of capacitance (kVAR Correction) to correct the power factor. Monthly analysis is necessary because power and energy use vary from month to month. The worksheet shows monthly amounts of demand (kW), kilovolt-Amperes Reactive (kVAR), kilovolt-Amperes cost (kVA$), and kVA, actual ($kVA_a$), billed ($kVA_b$), and proposed ($kVA_p$). The Proposed Cost Savings table shows the reduction in kVA charges for each amount of kVAR Correction. The Proposed Cost Savings (PCS) for each month is found from

$$PCS = kVA\$ \times \%TP \times [kVA_a - kVA_p]$$

The Savings and Cost Summary table shows proposed kVAR correction, cost savings, implementation cost, and simple and incremental payback. We choose the optimum amount of correction based on incremental payback. The incremental payback is the ratio of the implementation cost and cost savings for each additional increment of kVAR. Once the optimum is selected, the total annual cost savings (CS) are determined, along with the simple payback. We also attempted to limit proposed power factor to around 90% to reduce the chance of overcorrecting and reducing system stability.

The best combination of cost savings and payback was found by adding 2,500 kVAR of capacitance. The annual cost savings would therefore be

$$CS = \$76{,}739\ /yr$$

The following table summarizes the savings associated with reducing total power charges.

Savings Summary			
Source	Quantity Units	Energy 10^6Btu	Cost $
Reactive Power	2500 kVAR	0	$76,739

Implementation Cost

Assuming an installed cost of approximately $20/kVAR, the implementation cost (IC) would be

$$IC = 2{,}500\ kVAR \times \$20/kVAR$$
$$= \$50{,}000$$

The cost savings will pay for the implementation cost in 0.8 years.

Automatic power factor correction is also available that automatically adds the correct number of capacitors to maintain the optimum power factor as plant electric loads change. However, the cost is approximately three times as great and the payback three times as long.

Note:

We recommend coordinating reactive power correction with your electric utility for two reasons. One, you have an agreement in place regarding total power charges. Two, the existing capacitors on the distribution system may have additional system effects to consider. We have talked with your electric utility about these matters, but recommend that you also check before implementing this recommendation.

In general, small motors often can be corrected as a group at the motor control centers. On larger motors, we recommend installing capacitors at the motor starter. The capacitors will disconnect automatically when the motor is not operating to prevent over-correction. In no case do we recommend over-correcting the power factor.

The determination of the optimum power factor correction and the installation and location of the capacitors may require additional engineering. We recommend that additional professional advice, if needed, be obtained from a capacitor supplier or an engineering firm.

If soft-start motor starters or motor load controllers are being used, the capacitors may require installation ahead of the controller. Placing capacitors between the controller and the motor may result in damage to the controller and other equipment. We recommend following the controller manufacturer's recommendations when installing capacitors.

There are additional benefits from improving power factor. Less total current flows in the plant wiring, motors, and other equipment. Less current means reduced power losses with resulting energy and demand savings. However, energy savings due to these power losses are typically less than 1% of plant electricity use.

Other benefits from improved power factor are that motors run cooler and that system voltage is higher. Therefore, motor efficiency, capacity and starting torque will also be slightly higher. Branch circuit capacity also is higher because more real work can be done with the same total current.

Report No. 401

POWER FACTOR CORRECTION

Meter Number:	2210605
Total Power Charge:	$4.75 /kVA
Correction Cost per kVAR:	$20 /kVAR

Present Conditions				Proposed Power kVA				
				kVAR Correction				
Month	kVA	kW	pf	1,500	2,000	2,500	3,000	3,500
Aug-00	2,772	1,774	64%	1,883	1,779	1,812	1,976	2,242
Sep-00	3,696	2,365	64%	2,719	2,510	2,390	2,371	2,456
Oct-00	3,780	2,419	64%	2,797	2,583	2,453	2,421	2,491
Nov-00	3,780	2,419	64%	2,797	2,583	2,453	2,421	2,491
Dec-00	4,032	2,580	64%	3,035	2,804	2,649	2,582	2,612
Jan-01	4,032	2,580	64%	3,035	2,804	2,649	2,582	2,612
Feb-01	4,200	2,688	64%	3,195	2,955	2,785	2,698	2,702
Mar-01	4,200	2,688	64%	3,195	2,955	2,785	2,698	2,702
Apr-01	4,200	2,688	64%	3,195	2,955	2,785	2,698	2,702
May-01	4,200	2,688	64%	3,195	2,955	2,785	2,698	2,702
Jun-01	4,116	2,634	64%	3,115	2,879	2,716	2,639	2,656
Jul-01	4,158	2,661	64%	3,155	2,917	2,750	2,668	2,679

Present Conditions				Proposed Cost Savings				
			kVA	kVAR Correction				
Month	kVA	kVAR	Charge	1500	2000	2500	3000	3500
Aug-00	2,772	2,130	$ 13,167	$4,225	$4,718	$4,559	$3,781	$2,520
Sep-00	3,696	2,840	$ 17,556	$4,643	$5,633	$6,205	$6,294	$5,891
Oct-00	3,780	2,904	$ 17,955	$4,668	$5,687	$6,304	$6,455	$6,121
Nov-00	3,780	2,904	$ 17,955	$4,668	$5,687	$6,304	$6,455	$6,121
Dec-00	4,032	3,098	$ 19,152	$4,735	$5,831	$6,570	$6,886	$6,747
Jan-01	4,032	3,098	$ 19,152	$4,735	$5,831	$6,570	$6,886	$6,747
Feb-01	4,200	3,227	$ 19,950	$4,773	$5,914	$6,723	$7,136	$7,116
Mar-01	4,200	3,227	$ 19,950	$4,773	$5,914	$6,723	$7,136	$7,116
Apr-01	4,200	3,227	$ 19,950	$4,773	$5,914	$6,723	$7,136	$7,116
May-01	4,200	3,227	$ 19,950	$4,773	$5,914	$6,723	$7,136	$7,116
Jun-01	4,116	3,163	$ 19,551	$4,754	$5,874	$6,649	$7,015	$6,936
Jul-01	4,158	3,195	$ 19,751	$4,764	$5,894	$6,686	$7,076	$7,027

Savings and Cost Summary					
Proposed kVAR:	1500	2000	**2500**	3000	3500
Cost Savings (CS, $/Yr):	$56,284	$68,812	**$76,739**	$79,394	$76,575
ECO Cost (IC, $):	$30,000	$40,000	**$50,000**	$60,000	$70,000
Payback (Years):	0.5	0.6	**0.7**	0.8	0.9
Incremental Payback (Years):		0.8	**1.3**	3.8	-3.5