US DRIVES, INC.

Made In the U.S.A.

US Drives Inc.
2221 Niagara Falls Boulevard
P.O. Box 281
Niagara Falls, NY 14304-0281
Tel: (716) 731-1606 Fax: (716) 731-1524
Visit us at www.usdrivesinc.com

APPLICATION NOTES

- Centrifugal Fans - *Energy Savings / VFD Payback Analysis*

The energy savings potential for your fan based system when upgrading to **US Drives Variable Frequency Drives (VFD's)** is dependent upon several factors. Some of which are the original design philosophy of the system, the flow modulation method, system duty cycle, and your cost of electricity.

If the original design philosophy was to design for the worst case maximum flow condition for a future requirement or the designer used the usual 20% oversizing criteria, your potential for savings is very good. If, however, expansions have occurred over time and the system is near full flow capacity, your potential for savings may be limited.

The existing flow modulation method used on the system will determine the potential for energy savings when using VFD'. The savings potential is quite large if there is no modulation present as in the case of **Constant Volume** or **Uncontrolled** systems. **Outlet Damper** controlled systems use less energy than those using constant volume but the savings potential when using VFD's is still quite high. Systems using **Inlet Guide Vanes** are even more energy efficient than the above methods, but still leave the possibility for savings. Figure 1 illustrates the system curves for the above mentioned flow control methods.

The **Duty Cycle** of your system (where the system operates and for how long) will also affect potential savings. If, for instance, the system tends to operate close to the **Design Point** for the majority of the time, the savings potential through speed control is limited. On the other hand, if the system is operating at reduced flows for extended periods of time, the potential savings by using VFD's is great.

Obviously, the cost of electricity plays a major role in your consideration of whether motor speed control makes economic sense. If the rate of electricity is $0.02 per KWHr, the chances are slim that you'll be able to cost justify a Variable Frequency Drive for your system. However, If the electricity rate is $0.10 per KWHr or higher, you can expect to show fast paybacks for virtually any system.

Table 1 gives an indication of the energy savings realized by applying **US DRIVES VFD's** to building fans. Although each system has its own characteristics, (fan curve, fan efficiency, design point, duct losses, motor efficiency, etc.) the typical savings expected on different motors can be estimated.

Table 1
Typical $ Saved Per Year On HVAC Building Fans*

	Constant Flow	Output Damper Control	Inlet Vane Control	With US Drives VFD
30 HP	None	$3,200	$9,000	$15,200
50 HP	None	$5,400	$15,000	$25,400
100 HP	None	$10,800	$30,000	$50,800
250 HP	None	$27,200	$75,400	$126,600
400 HP	None	$43,400	$120,600	$202,400

*Based on a conservative $.10 per kilowatt hour and 8000 hours of operation per year.

The information necessary to run a VFD Payback Analysis for your fan system is indicated on the "Centrifugal Fans Energy Savings Program Data" sheet (Doc. # 3010).

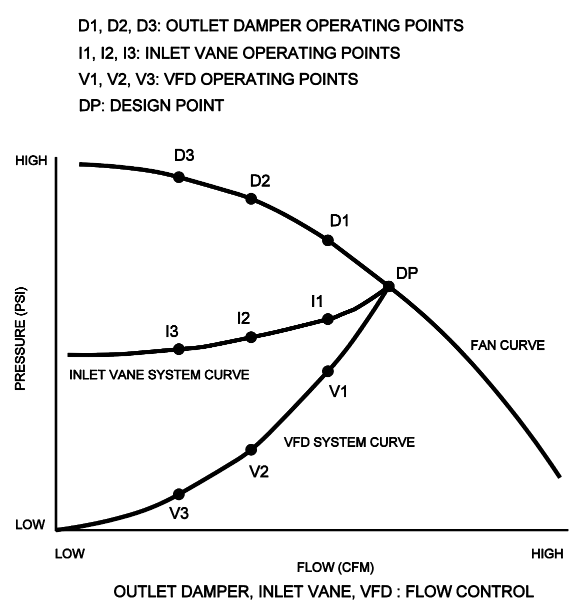

Figure 1.

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APPLICATION NOTES

- Centrifugal Fans - *Energy Savings / VFD Payback Analysis*

CUSTOMER DATA:

DATE: ____________

CUSTOMER NAME ______________________________________

PROJECT NAME ______________________________________

CITY ________________ STATE/PROV _____ ZIP/POSTAL CODE __________

CONTACT ____________________ PHONE _________

APPLICATION PARAMETERS:

	DATA	
FAN EFFICIENCY	________	%
DESIGN FLOW	________	CFM
DESIGN PRESSURE	________	PSI
	________	IN. OF WATER
MOTOR HP	________	HP
MOTOR VOLTAGE	________	VOLTS
MOTOR EFFICIENCY	________	%
COST OF ELECTRICITY	________	/KWH
METHOD OF CONTROL (SPECIFY 1, 2 or 3)	________	SELECTION

1: UNCONTROLLED
2: OUTLET DAMPER
3. INLET VANE

DUTY CYCLE (SPECIFY 1 or 2)	________	SELECTION

1: USE TYPICAL DUTY CYCLE AND **SPECIFY** TOTAL OPERATING HOURS/YEAR ______ HOURS
2: USER SUPPLIED (SEE BELOW)

DUTY CYCLE DATA:

OPERATING POINT	1	2	3	4	5	6	7	8	TOTALS
% FLOW	___	____	___	____	____	____	____	____	________
HOURS	___	____	___	____	____	____	____	____	________

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APPLICATION NOTES

- Centrifugal Pumps - *Energy Savings / VFD Payback Analysis*

The energy savings potential for your pump based system when upgrading to **US Drives Variable Frequency Drives (VFD's)** is dependent upon several factors. Some of which are the original design philosophy of the pump system, the flow modulation method, system duty cycle, and your cost of electricity.

If the original design philosophy was to design for the worst case maximum flow condition for a future requirement or the designer used the usual 20% oversizing criteria, your potential for savings is very good. If, however, expansions have occurred over time and the system is near full flow capacity, your potential for savings may be limited.

The **VFD system curve** is derived by selecting an operating point on the desired **pump curve** and connecting the operating points of the revised pump curve as calculated by the affinity laws through the **static head** point, (SH). If the static head is high, the system curve can approach a **Constant Pressure** design (System C.P.). If the static head is low, the system curve will resemble the VFD system curve shown in Figure 1. **Basically, the lower the static head is, the greater the energy savings that will be achieved by using VFD's**. This does not mean that savings can not be realized by using VFD's on a constant pressure system - each installation must be evaluated on its own merit.

The existing flow modulation method used on the system will also affect the potential for energy savings when using VFD's. If **Bypass** Control is used, the system is always operating at point DP. If the system uses **Outlet Valve** Control, it operates along the pump curve from point DP to point P3. If a VFD is being used for pump speed control, the system operates along the VFD system curve from point DP to point V3.

The savings potential is quite large if there is no modulation present as in the case of **Uncontrolled** or **Constant Flow** systems. **Outlet Valve** controlled systems use less energy than those using constant flow.

The **Duty Cycle** of your system (where the system operates and for how long) is another factor that will affect potential savings. If, for instance, the system tends to operate close to the **Design Point** for the majority of the time, the savings potential through speed control is limited. On the other hand, if the system is operating at reduced flows for extended periods of time, the potential savings by using VFD's is great.

Obviously, the cost of electricity plays a major role in your consideration of whether motor speed control makes economic sense. If the rate of electricity is $0.02 per KWHr, the chances are slim that you'll be able to cost justify a Variable Frequency Drive for your system. However, If the electricity rate is $0.10 per KWHr or higher, you can expect to show fast paybacks for virtually any system.

Table 1 gives an indication of the energy savings realized by applying **US DRIVES VFD's** to centrifugal pumps. Although each system has its own characteristics, (pump curve, static head, pipe losses, pump efficiency, etc.) the typical savings expected on different motors can be estimated.

Table 1
Typical $ Saved Per Year On HVAC Centrifugal Pumps*

	Constant Flow	Outlet Valve Control	With US Drives VFD
30 HP	None	$3,360	$15,500
50 HP	None	$5,600	$25,800
100 HP	None	$11,200	$51,600
250 HP	None	$28,000	$129,200
400 HP	None	$44,800	$206,600

*Based on a conservative $.10 per kilowatt hour, zero static head and 8000 hours of operation per year.

The information necessary to run a VFD Payback Analysis for your pump system is indicated on the "Centrifugal Pumps Energy Savings Program Data" sheet (Doc. # 3011)

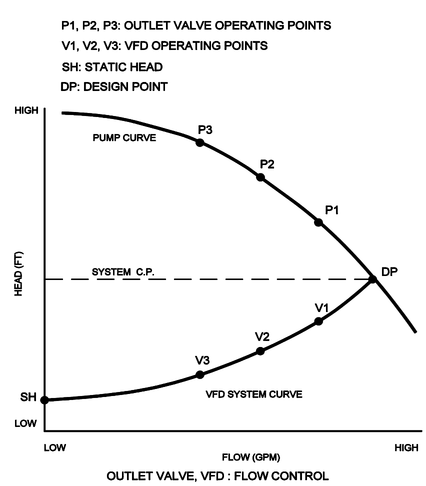

Figure 1

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APPLICATION NOTES

- Centrifugal Pumps - *Energy Savings / VFD Payback Analysis*

CUSTOMER DATA:

DATE: ____________

CUSTOMER NAME ____

PROJECT NAME ____

CITY ________________ STATE/PROV _____ ZIP/POSTAL CODE _________

CONTACT ____________________ PHONE _________

APPLICATION PARAMETERS: DATA

APPLICATION PARAMETERS	DATA	
PUMP EFFICIENCY	________	%
DESIGN FLOW	________	GPM
DESIGN HEAD	________	FEET (WATER)
STATIC HEAD	________	FEET (WATER)
MOTOR HP	________	HP
MOTOR VOLTAGE	________	VOLTS
MOTOR EFFICIENCY	________	%
COST OF ELECTRICITY	________	/KWH
METHOD OF CONTROL (SPECIFY 1 or 2)	________	SELECTION

1: UNCONTROLLED
2: OUTLET VALVE

DUTY CYCLE (SPECIFY 1 or 2) .... ________ SELECTION

1: USE TYPICAL DUTY CYCLE AND **SPECIFY** TOTAL OPERATING HOURS/YEAR ______ HOURS
2: USER SUPPLIED (SEE BELOW)

DUTY CYCLE DATA:

OPERATING POINT	1	2	3	4	5	6	7	8	TOTALS
% FLOW	___	___	___	___	___	___	___	___	________
HOURS	___	___	___	___	___	___	___	___	________

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APPLICATION NOTES

- Cooling Tower Fans -

Energy Savings / VFD Payback Analysis

The cooling tower is a simple device. It moves air through falling water to cool the water. The air absorbs heat by carrying away hot water vapor and thus cools the remaining water.

What makes cooling tower analysis and design seemingly difficult is the thermodynamic characteristics of air and water. As air moves through water, it absorbs heat depending upon the difference between the "wet bulb" temperature of the air and the inlet water temperature. This difference dictates how much heat is eliminated per unit of air and water. To increase heat removal at steady state temperatures, the flow of air through the water must be increased. To decrease heat removal, the flow of air through the water must be decreased. The amount of heat removal is directly proportional to the flow of air through the water.

The function of the cooling tower is to deliver outlet water at a specific temperature to permit optimum heat removal at the chiller or other heat source. As the "wet bulb" temperature varies, the heat removal capacity of cooling tower varies. The colder the "wet bulb" temperature of the air is, the less the flow of air required to remove a given amount of heat.

A cooling tower fan is designed to supply adequate air to cool the water to a specific temperature when the air is very hot and humid (design "wet bulb" temperature). The atmosphere, however, is at this design point condition only 2 to 5% of the operational time. Consequently, reductions in air flow can be achieved 95 to 98% of the time.

Remembering fan fundamentals, if one reduces the flow of air by use of motor speed control, one can save energy by the cube of the speed reduction ratio. Thus, a 10% flow decrease can produce a 27% reduction in power use.

Table 1 shows typical savings realized by applying **US DRIVES VFD's** to cooling tower fans. Although each system has its own characteristics, (length of cooling season, fan curve, fan efficiency, design point, etc.) typical operating costs and savings on different motors can be estimated.

Table 1
Typical Savings Per Year For Cooling Tower Fans*

Single Cell HP	VFD applied to On/Off Control	VFD applied to Two/Speed Motor Control
25 HP	$2,425	$1,020
50 HP	$4,850	$2,045
100 HP	$9,700	$4,090
150 HP	$14,550	$6,130
200 HP	$19,400	$8,170

*Based on a conservative $.05 per kilowatt hour and cooling season of 3000 hours.

The information necessary to run a VFD Payback Analysis for your cooling tower fan system is indicated on the "Cooling Tower Fans Energy Savings Program Data" sheet (Doc. # 3012).

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CUSTOMER DATA:

DATE: ____________

CUSTOMER NAME____

PROJECT NAME____

CITY____________________ STATE/PROV. ____________ ZIP/POSTAL CODE___________

CONTACT __________________________PHONE ______________

APPLICATION PARAMETERS: DATA

APPLICATION PARAMETERS	DATA
NUMBER OF CELLS …..…………………………………..…	_________ (8,6,4,2,1)
CELL FAN EFFICIENCY ………..……………………………	_________ %
SINGLE CELL DESIGN FLOW …..………………..………..	_________ CFM
SINGLE CELL DESIGN PRESSURE ……………………….	_________ PSI
	_________ IN. OF WATER
MOTOR HP ………..…………………………………..……	_________ HP
MOTOR VOLTAGE …………………………………………..	_________ VOLTS
MOTOR EFFICIENCY ………………………………………	_________ %
COST OF ELECTRICITY ………………………………....	_________ /KWH
METHOD OF CONTROL (SPECIFY 1 or 2) ………………	_________ SELECTION

1: ON/OFF CONTROL
2: TWO SPEED MOTOR

TOTAL HOURS OF OPERATION ……………………………	_________ HOURS