

## NEVADA SURE BET PROGRAM

Offered By: NV Energy

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### *Variable Speed Motor Drives – Many Applications to Save Energy*

Air, water or refrigerant flow in a fan, pump or compressor system is typically controlled by an automatic valve or damper that restricts the flow. Devices that control flow by imposing a pressure drop are inefficient and result in energy waste. Control of flow can be accomplished more efficiently by varying the speed of the device. The speed of the pump or fan can be controlled by several means including a variable pitch sheave, gearbox, or slip clutch but the most efficient and most common means is controlling the motor speed itself. Today, motor speed control is accomplished most commonly by varying the characteristics of the electric power wave that is supplied the motor. The electronic devices that accomplish this are generally referred to as adjustable speed drives (ASDs), however, as frequency is most often the characteristic varied they are most often referred to as variable frequency drives or VFDs.

VFDs save significant energy because they accomplish flow control by varying the speed of the motor driving the pump or fan, rather than using a valve or damper to induce a pressure drop. VFDs save considerable power at part load flow. This is a result of two fan or pump “affinity laws”<sup>(1)</sup>.

- First, flow varies (approximately) with the rotational speed of a pump or fan. This means that a ten percent reduction in speed will result in a ten percent reduction in flow.
- Second, depending on the operating characteristics, the power input to the pump or fan varies with the **CUBE or SQUARE** of the rotational speed. This means that a 10 percent reduction in flow, can mean a reduction in power input of  $(1 - 0.9^3) = 27\%!!!$  The savings increase exponentially so as the flow rate and pump speed decrease, the reduction is even more dramatic.

Controlling motor speed to control capacity has many cost-effective applications. Some of the more common ones are described below:

#### **Key Applications**

**Cooling Tower Fans** – Cooling towers are great candidates for VFD control because they can operate long hours at part loads, particularly with Nevada’s desert climate, where there are multiple towers installed, the greatest savings can often be achieved by operating with all of the fans operating in “parallel” at a low speed controlled by a common speed signal.

**Centrifugal Chillers (Refrigeration Compressors)** – Centrifugal refrigerant compressors found in many large chillers respond in a similar manner to fans. Constant speed compressors typically use inlet vanes to restrict refrigerant flow at the compressor inlet to achieve part load capacity. Varying the speed of the compressor can

achieve partial capacity operation at a much lower power level. VFDs can be retrofitted on most existing chillers (consult the manufacturer) and many manufacturers now provide a VFD-driven chiller as a high-efficiency option.

***Air Moving Fans or Industrial Blowers*** – In the past, the flow in most variable-flow air moving systems was controlled by a damper at the inlet of the fan scroll or in some cases by a variable-pitch drive sheave. Flow in some industrial systems is controlled using by-pass air or discharge dampers which are even less efficient. For most of these applications a VFD is much more efficient and retrofit is very cost-effective.

***Pump systems*** - Water flow for HVAC applications: hot or cold water distribution, irrigation or industrial cooling is often controlled by either cycling on/off, by-passing flow, or throttling with a valve in the piping system. Controlling flow by varying the pump speed electronically offers significant energy and cost savings and often more precise operation.

***Miscellaneous Equipment and Industrial Process Systems*** – VFDs offer a cost-effective means of capacity control in many industrial process and support systems. Common cost-effective applications include material conveyor systems, elevators, induction molding machines, process air compressors, wastewater treatment, purification systems, etc.

### ***Application Issues***

There are several issues that those considering VFDs should be aware of. These are discussed briefly below:

- VFDs do not save energy when the fan or pump is at or near 100% load. In fact a VFD driven system will usually use more power than a comparable constant speed system at full flow. So VFDs may not provide savings or be cost-effective for systems that are not designed for partial loading. In other words, a drive in and of itself will not save energy unless the system operates at part load at least some of the time. Retrofitting a drive on a system designed for a constant flow will not save energy unless it operates at part capacity much of the time; this is the case in most HVAC applications.
- A second benefit to installing a VFD is its “soft start” capabilities. The VFD allows the motor to “ramp up” to its operating speed by gradually raising the power level. This reduces wear and tear especially on motors that start and stop often or with a high starting torque. Conversely if a “soft start” on a motor is needed for the above reasons, a VFD should be considered for the purpose as it adds the potential for dynamic speed control at not much higher cost.
- Some older motors may not be suitable for variable speed control due to the way they are wired or internally protected. The motor compatibility should be confirmed (or the motor replaced) prior to retrofitting a drive on an existing motor.
- VFDs can produce harmonic “noise” that may be unacceptable on circuits with electronic equipment or controls. Although this effect is minimized with newer VFDs, an isolation transformer may be necessary to ensure this “noise” does not impact electronic equipment.
- Some driven equipment (fans or pumps) may produce excessive noise or may not operate properly at certain speeds. Controls will need to be installed to ensure that the drive does not operate in this range.