



---

## **Process and Motor Controls in Central and Remote Buildings: PlantWeb Center, the Intelligent Remote Building**

---

This paper introduces the PlantWeb Center and the use of Intelligent Motor Control.



© Emerson Process Management 1996—2007 All rights reserved.

DeltaV, the DeltaV design, SureService, the SureService design, SureNet, the SureNet design, and PlantWeb are marks of one of the Emerson Process Management group of companies. All other marks are property of their respective owners. The contents of this publication are presented for informational purposes only, and while every effort has been made to ensure their accuracy, they are not to be construed as warranties or guarantees, express or implied, regarding the products or services described herein or their use or applicability. All sales are governed by our terms and conditions, which are available on request. We reserve the right to modify or improve the design or specification of such products at any time without notice.





## Contents

<b>Introduction</b>	<b>3</b>
<b>Basis of Comparison</b>	<b>4</b>
<i>Legacy DCS or DeltaV</i>	4
<i>UPS Systems</i>	4
<i>Motor Control Center or IEC Contactors</i>	5
<i>Central Control Building or Remote I/O Center</i>	5
<b>Cabling Comparisons</b>	<b>6</b>
<b>DeltaV: The Largest Difference</b>	<b>6</b>
<b>Summary</b>	<b>8</b>
<b>PlantWeb Center—The Intelligent Option</b>	<b>10</b>



## Introduction

There are many reasons to locate controls either at the operating structure or several hundred feet away in a central location. Preference and precedent are strong reasons for centralization; they support the pattern established years ago. Maintenance personnel are often staffed in the central building adjacent to the I/O and motor control center rooms. This has become less important as these systems have improved. Less maintenance is required, and much of it can be managed from the unit or plantwide central facility with HART or FOUNDATION fieldbus derived information transmitted to any company site. Intelligent VFDs and motor controls are here now and much more information is available from these newer systems than we have been accustomed to getting.

Capital cost is a stronger factor than ever. This is because of additional choices not available just a few years ago. Relatively recent technologies which, when combined, make a strong case for decentralization include:

- Scalable hybrid digital control systems, the DeltaV system, for example
  - A subset of the DeltaV system, along with a trend to 24VDC-powered instruments is a reduction of the UPS system.
- Finger-safe IEC motor control, with performance matching that of traditional MCCs.
- The quality of remote I/O centers, along with the ability to communicate via Ethernet or other bus systems.
  - A subset of remote centers is a large reduction in cabling.

The scope of this study is defined by an actual project executed by FABCON in 1998. It was a remote I/O building containing DCS (PROVOX) I/O and traditional NEMA motor control centers (MCCs).

Pertinent counts are:

• UOC controllers, 320 point	2	
• HART analog in points		144
• HART analog out points	16	
• Discrete points, in & out	508	
• Size 1 starters	40	
• Size 2 starters	4	
• Size 3 starters	4	
• Size 4 starters	4	
• Size 5 starters	5	
• 30 ampere fusible switch units	11	
• 60 ampere fusible switch units	7	



## Basis of Comparison

### *Legacy DCS or DeltaV*

The PROVOX project contained the I/O listed in the introduction as well as controllers. Terminals and software, while not located in the remote I/O center, were also included. From these P.O. line items, an equivalent DeltaV system was specified and priced. The DeltaV prices were list.

The DCS system was, of necessity, enclosed in cabinets. Because of its IP20 finger-safe design, the DeltaV system can be surface- or rail-mounted. The cabinet pricing is included in the DCS total.

The DeltaV equivalent hardware was split into two systems. These, combined, consisted of:

2	M5 Plus controllers
3	Passthrough power supplies
4	2-wide carriers
8	8-wide carriers
18	8-point HART analog in cards
2	8-point HART analog out cards
7	32-point discrete in cards
37	8-point discrete out cards

Configuration was not addressed.

### *UPS Systems*

An item greatly affected by choice of digital control system needs is required power. Another factor that affects instrument power is the almost complete availability of instruments accepting 24 VDC power at lower usage levels.

PROVOX, along with other legacy systems, uses AC input DC power supplies. In the PROVOX case, two AC inputs could be furnished to the power supply for some level of redundancy. The power supply output is still common, but multiple units can be paralleled. At the advent of DCS control systems, many field devices still required 120 VAC for power.

This leads to a cumbersome design if you want to stay online for some time after a power failure. One of the AC supplies is from a UPS and the other from a 120 VAC distribution panel supplied from an MCC via a step-down transformer. The UPS consists of a 480 VAC, from a different MCC, to 24 VDC rectifier, a battery bank, a 24 VDC to 120 VAC inverter and a static switch. The battery design is 14 minutes of operation. Examining the UPS system confirms that several conversions are made. They are:

- 480 VAC to 24 VDC in the UPS
- 24 VAC to 120 VAC in the UPS
- 120 VAC to 24 VDC in the DCS system

The system proposed for DeltaV and field instruments is a 480 VAC to 24 VDC rectifier capable of trickle charge and a 14-minute battery. This 24 volts is distributed to 2-wide carriers for system power and to 8-wide carriers for field power. To furnish even more security than the UPS above, a second source is a 120 VAC to 24 VDC rectifier and equivalent battery bank fed from a lighting panel. With intelligent switching, we have twice the time, and one battery can be serviced or replaced while we still have backup from the other.



The inefficiency losses involved above would consume 4 KVA of the 10 KVA UPS if each conversion has 15% loss. 20% is a more likely number. After correcting for latent heat, more than 1½ tons of air conditioning would be needed for just these losses.

### ***Motor Control Center or IEC Contactors***

The three MCCs were requested to essentially match the 1998 project. The list of combination starters and switches are as listed in the introduction. Each Mcc has an 800-ampere disconnect for incoming power and 800 ampere horizontal buses. The lineup is a 4-section back-to-back MCC and two 3-section back-to-back MCCs. All equipment is fusible.

This array was matched by quotes from the same vendor for equivalent IEC contactors and overload relays. In addition, fused switches and IEC bus systems from a major circuit protection vendor were priced in. Again, all equipment is IP20 finger-safe or is furnished with protective shrouds to accomplish a non-contact electrical system.

MCCs are in their normal rugged metal enclosures. That means a size 1 starter takes up 1.4 cubic feet of space. In a front only array, 2.8 cubic feet would be used. By contrast, an IEC equivalent requires less than 0.1 cubic feet. Required clearance spaces for each compound this difference.

Heat dissipation for the 20 sections of MCC is, by G.E. estimating techniques, 8333 watts. After conversions and corrections, this is a need for 3.8 tons of cooling if cooled to comfortable personnel conditions. This could be in order if the space is shared with legacy DCS gear, limited to around an 85 F, environment. A case can be made for ventilation in northern climes, but Gulf Coast locations present a need for huge amounts of cooling air as the ambient temperatures approach 104 F., the MCC limit. The drawbacks to huge amounts of cooling air are fan size, motor horsepower and their footprint, and the need for large filter installations with significant maintenance requirements.

The IEC arrangement loses about 2000 watts, a less than 1-ton penalty.

### ***Central Control Building or Remote I/O Center***

This whitepaper is to show the documented advantages of placing a majority of the control systems as close as reasonable to the process being served. Three types of buildings will be considered.

First is dedicated room(s) in a masonry control building, designed by an architect or experienced plant facilities designer. Next is a large rugged painted steel panel structure with a structural base hefty enough to resist changes due to lifting, loading and unloading. The last case, size permitting, is a modular panel system of steel-clad foam composite wall and roof panels mounted on a FABCON structural base and floor.

The space requirement for the DCS and MCC installation is 480 square feet in either location. For DeltaV and MCCs, 400 square feet is needed, and for DeltaV and IEC gear, 208 square feet will fill the bill. With a cable tray system over the MCCs, 12 feet is in order from floor to ceiling. In the last case, because all items are wall mounted, either surface- or rail-, the tray can be outside—meaning an 8-foot tall building will suffice.

To look at this another way, the first two cases need 5760 and 4800 cubic feet respectively, while the last case uses 1664 cubic feet.

Lighting is proportional to area, and HVAC requirements are a function of the volume.



## Cabling Comparisons

This comparison is based on these assumptions:

The central control building is 750 feet (note 1) from the process unit. Junction boxes are in the process structure to collect power and control cables. From these boxes, multi-pair instrument cables and multi-conductor control cables are run to the control building. Also field devices are 100 feet (note 1) from the junction boxes.

The remote I/O building is 250 feet (note 1) from the process and all cables are run from the device to their termination in the building. The central control building is 750 feet from the remote I/O building. No junction boxes are used.

A further assumption is that the 480 VAC source is between the buildings. If it is located beyond the control building from the process, the additional 4500 feet for the 6 feeders will negate other cable savings.

An additional feature is that elaborate grounding is not needed for the DeltaV system as it was with the DCS systems.

Note 1: these are averages for purposes of estimating cables.

## DeltaV: The Largest Difference

This was the most startling difference, a 69% reduction for the DeltaV case. Note that the prices are not estimated. The DCS data is from copies of purchase orders and the DeltaV system is priced at list. Although not installed in the I/O room, wherever located, consoles and control software are included.

The installed DCS system is \$304,000 including cabinetry. The installed DeltaV system is \$94,000 including mounting on plates. Because of the large difference, this case is for historical reference only. However, as this is being written, a project similar to that used in this comparison is in the FABCON shop; and that includes PROVOX.

The 69% reduction equates to \$210,000.

Reductions in area and HVAC needs will be reflected in the buildings' comparisons.

The UPS system is similarly downsized both in capacity and complexity.

A 10KVA UPS was purchased for the 1998 project for \$16,900.

Getting even more protection without the DC/AC inverter and second AC/DC conversion can be done as described for \$5000 installed versus the \$17,000 for the UPS

This is a reduction of 70% or \$12,000.

In addition, a smaller area is in order, less heat is generated and a transformer and distribution panel are eliminated. These show up in the buildings' comparisons.



## IEC Motor Control Advantages

The actual 1998 project used an MCC considered to be very “top of the line.” I chose to get current quotes from a more competitive vendor for both the NEMA and IEC versions. The NEMA system is \$60,000 installed, the IEC system \$34,000.

This is an installed difference of \$26,000, or a 43% reduction.

As above, the area and HVAC reductions are in the buildings’ comparisons.

## Remote I/O Centers have the Edge

The building site and type are influenced by other factors, principally preference and the equipment to be housed. Although three different sizes and three types of construction are considered, the cost differential for each central versus remote option is fairly constant at \$20,000. It is when the leap is made to smaller, more efficient equipment combined with placing I/O adjacent close to the process that real savings are realized.



## Summary

The cost differentials mentioned throughout this paper are displayed in the table below.

Location	Control Type	Motor Control	Control System	Motor System	Cables	UPS	Building	TOTAL
Central	DCS	MCC	304000	60000	90000	17000	96000	<b>567,000</b>
Central	DeltaV	MCC	94000	60000	90000	5000	80000	<b>329,000</b>
Central	DeltaV	IEC	94000	34000	90000	5000	45000	<b>268,000</b>
Remote	DCS	MCC	304000	60000	51000	17000	75000	<b>507,000</b>
Remote	DeltaV	MCC	94000	60000	51000	5000	60000	<b>270,000</b>
Remote	DeltaV	IEC	94000	34000	51000	5000	25000	<b>209,000</b>

The first and fourth cases are, at present, unlikely. As mentioned before, FABCON has an example of case 4 in our shop in April 2002. This apparently is an addition to a system in operation. However, new legacy DCS installations will not happen, or at least, should not.

The real savings comes when a DeltaV client adds the options of IEC motor control and placement of I/O adjacent to the process unit. This difference is exhibited in the second and last case.

The reduction is \$120,000 or 36.5%.

## Other Savings and Considerations

Only the hardware case has been considered. There are several other issues.

Design, development and documentation are much less with any system other than a DCS. Even in the PLC/HMI case, this can more than offset the hardware difference. Refer to DeltaV whitepaper "DeltaV versus PLC/HMI in a Highly Discrete Application" dated January 2002.

A standard documentation package; if FABCON standard components are used. These would be "fill in the variables" for layouts, schematics etc.

Discrete and continuous control devices designed to IP20 or higher are, in almost all cases, modular and easy to apply and amend. This is a considerable savings in engineering. A full service fabricator will have the skills on hand and not have to purchase engineering.

The high-value space freed-up by a migration from a central legacy system to a process-adjacent new system can be used for offices or IT systems. In a new installation, the building cost is reduced, or where available footprint is tight, the space can be better used.



With communications now available, a multi-unit plant migrating to the DeltaV system can include upgraded motor control in the remote I/O centers and consolidate I & E maintenance in a central location and perhaps reduce staff.

The next steps, of course, are control center centralization, asset management and integration with ERP.

Other issues are:

- Benefits of a single purchase order
- Reduce need to supervise construction crafts
- F.A.T. and simulation are possible before acceptance onsite
- Small components are reasonable enough to replace, not maintain
- Reduced engineering and architectural needs
- Ability to easily incorporate other systems such as:
  - Switchgear
  - Analyzers and sample systems
  - Pressurization, purges and air locks
  - Safety relay systems
  - Wet labs
  - Maintenance consoles

Perhaps the most important additional benefit is the ability to totally specify, furnish and document the I & E systems from sensor, valve and motor through the human interface and beyond, fully configured and ready to use.



## PlantWeb Center—the Intelligent Option

The most advanced version of remote I/O buildings by FABCON is the “PlantWeb Center.” This center combines all latest technologies for optimal use of smart digital asset management. In particular, the product utilizes Foundation Fieldbus and Device Net communications to further minimize wiring.

Hardware costs are about equivalent to the DeltaV—IEC Remote case. There are savings in wiring, power and building size; however, the added cost of intelligent hardware roughly equals those savings. The use of multi-variable transmitters can further reduce I/O cards as well as wiring. The real savings, however, comes from the powerful checkout, configuration, maintenance, operations and asset management features. Because this paper concentrates on hardware and documentation aspects, we will not address these benefits available with Emerson and other FOUNDATION fieldbus devices.

The motor control features are worth mentioning because they are new to much of the Emerson Process Management community. Besides eliminating the need for hard-wired start, stop and run feedback; the following information is available:

- Ground fault detection
- Thermal overload pre-warn
- Phase loss or unbalance
- Communication errors
- Average RMS motor current
- Memory of previous faults
- Underload condition

Variable frequency drives, particularly those by Control Technologies, offer the above and more. Additional variables include:

- Speed
- Direction
- Trip codes
- Frequency
- Preset speeds
- High and low speed alarms
- Drive health
- Braking information
- Trip, jog and reverse commands

This is the highest technology available to processing industries. When combined with the “PlantWeb Center” completely configured, tested and simulated power and control systems can migrate pneumatics to intelligent digital systems in weeks rather than months. The migration from DCS can make weeks become days.