Save Time and Money by Designing Effective Interface with Vendor-provided control systems

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ABSTRACT
A coordinated design effort is necessary to successfully integrate, in a timely manner, vendor-provided control systems in a plant-wide SCADA system. Progress in field startup operations could be hampered due to issues arising from: mismatched communication protocols between the plant SCADA network and vendor provided controls network, the vendor’s understanding of the desired process control, monitoring and control signal availability from the vendor-provided control system, data mapping and tagging schemes between the two systems, permissive signals needed to execute proper sequence of operation and fail-safe requirements, and alarms and fault display requirements. Resolving these issues in the field could prove costly in terms of construction service expenses and startup delays.

Providing the desired process control when integrating with vendor-provided control systems requires coordination at various design levels. The design intent and methodology should be clearly defined in the contract documents such that the plant SCADA system integrator and the vendor system supplier have enough information to plan ahead and work together throughout the project. This paper will present best practice methods during design to minimize coordination issues thus preventing construction cost surges, startup delays and potential plant downtime.
INTRODUCTION

Modern municipal water/wastewater treatment facilities utilize various vendor-provided control systems as part of the plant-wide SCADA infrastructure. To name a few, Air Blowers system, Belt Filter Press System, Polymer feed system etc., are packaged with mechanical and electrical equipment, instrumentation, and a control system. Vendor-provided control systems provide an effective subsystem to the plant SCADA utilizing vendor’s specialized knowledge of the supplied equipment and control philosophy. A vendor-provided package system may be supplied by a single vendor or in some cases supplied by multi-vendors with a representative. In the latter case, the representative vendor coordinates with other vendors who supply auxiliary equipment, and usually takes sole responsibility of the vendor package system.

Figure 1. Typical Control Panel for Vendor Package System

The design phase of a project typically involves automation design engineer working with process engineer, electrical engineer, vendor and end user to perform the coordination and develop contract documents. A project under construction typically requires coordination between the personnel from general contractor, system integrator, design engineer, vendor(s), electrical subcontractor, and last but not least, the end user at the facility. Due to the complexity in integrating one control system with the other, and a chain of coordination involving various organizations, issues are a common occurrence particularly if the design is not coordinated, and information on key areas is lacking. Some issues are
complex and can be difficult to set apart during the overall field testing phase. If the issues are left to be identified in the field rather beforehand, efforts to plan and troubleshoot in the field will not only cause delays but could prove expensive. Consequently, delays in testing can impede the startup and shift the overall project schedule further for days if not weeks. Delays in the schedule could prove expensive in terms of a firm’s construction services costs.

In the world of system integration and construction services time is money and resolving issues in the field is expensive due to added cost in travel, stay and other overheads. Designing an effective interface with vendor-provided control system with focus on key areas, and providing a sufficient guide and directions in the contract documents is crucial to minimizing the issues and control costs during construction.

Approach to design is outlined illustrating key areas where issues are most common while integrating vendor-provided control system with plant SCADA system. The design approach presented emphasizes on inter-disciplinary, vendor and end user coordination on key areas. The paper also discusses specifying general requirements to facilitate various organizations involved to work together on construction submittal exchanges, coordination meetings and workshops, and testing. The case studies are referenced in schematic representation where similar effective design approach presented was followed. Further recommendations based on the lessons learned from case study references are presented.

**KEY AREAS IN FOCUS**

Today several approaches to designing an interface with the vendor-provided control systems are followed in the water/wastewater industry. Best practice methods, and guidelines to designing an effective interface with vendor packaged systems are illustrated below. The methodology and guidelines are focused on key areas of integration where issues are a frequent occurrence.

- **Process Control Philosophy**

  Most vendors who specialize in a certain process system have a “standard” package system to offer. These standard packaged control systems operate by the vendor developed control philosophy, adhering to their standards. Control philosophy lays the foundation that dictates needs in other key areas of the integration. The standard vendor packaged system needs to be tailored to the project. If the control philosophy is not coordinated during design to tailor to the needs of the project, desired process control with proper monitoring and control cannot be achieved, resulting in additional time and money spent during construction to determine specific project needs.

  It is recommended that control philosophy be discussed with the vendor early in the design stage, so early planning of the integration process and identification of other issues can be set in motion. Intent and control objectives must be clearly understood through coordination with the Process design engineer, vendor and facility end user during the design phase. It is a good practice to discuss control strategies through coordination meetings and solicit control
narratives or sequence of operation documentation from the vendor. The design engineer should review the vendor narratives that were developed based on meetings and exchange comments. The control philosophy should be coordinated in the context of overall water/wastewater plant functioning and plant SCADA operation. This coordination exercise is necessary to lay the groundwork for customizing the standard packaged system from the vendor and is also beneficial in “fine tuning” the design of overall plant process control through the plant-wide SCADA system.

Figure 2. Typical Control Screen for Vendor Package System

- **Control System Components and Interfacing Method**

A complete vendor-provided control system usually includes a PLC, OIT, Ethernet switch, and a UPS each from a vendor standardized manufacture and model. Often times these components are a different manufacture or model from the plant SCADA components. Using dissimilar manufacturer or model components, the end user’s overall maintenance increases and may prove costly in the long run. Different manufacturer components require spare parts to be available separate from plant SCADA system. This is not desirable from a plant operator perspective on not being able to use same spares for either of the systems. Different manufacturers also lead to different maintenance services with the end user having to switch between vendors to obtain support. Different manufacturers require different programming software and licenses. This could prove expensive in having to maintain multiple software licenses and support agreements. Long term issues with mismatched control system
components include plant operator having to maintain multiple PLC platforms and spend additional time and budget to train new operators to gain familiarity with different operator interface terminals.

From a plant startup standpoint with different vendors, communication protocol within the vendor system PLC may be different from that used in the plant-wide SCADA system. This may be of minimal issue if the vendor-provided control system is integrated with plant SCADA system via hardwired analog and discrete signals as opposed to networking the systems via a communication link. If however a communication link is desired to integrate vendor-provided control system with plant SCADA system, additional time and budget may be spent in the communication setup due to mismatched protocols. The delays can become severe and even more expensive if the design is not well coordinated and documents do not specify an organization - either the vendor or the system integrator responsible for providing the required protocol converters.

Figure 3. Network layout for Vendor-provided Turbo Air Blowers Package System with link to the Plant SCADA system for City of Laredo, Texas.

Desired method of interfacing vendor system I/O with the plant SCADA system, such as hardwired signals or communication link should be established during design prior to a detailed coordination with the vendor. In some cases, combination of hardwired and communication link
method maybe desired by the end user. Key factors in establishing the desired method of interfacing are cost, desired monitoring, and construction complexity. Cost of providing I/O interface using hardwired signals vs. communication link should be evaluated. Desired monitoring remotely from SCADA should be considered in the decision making process. Not all alarms and vendor PLC diagnostic status signals can be monitored due the complexity of running many wires and conduits. Complexity in running multiple conduits for hardwired signals against running one conduit for a communication link through the facility infrastructure should be carefully coordinated with the electrical design engineer. The end user of the facility should be consulted for their preference in the method of interfacing two systems, and discuss the evaluation of hardwired interface vs. communication link.

Once a decision to go with hardwired signals or communication link is made, requirements should be coordinated with the vendor and obtain confirmation that they can be met. If using the communication link approach, exact protocol should to be coordinated and appropriate protocol converters need to be specified if required to match the protocol between two systems. Ideally, similar PLC manufacturer and model to that of plant SCADA system should be desired with the vendor to make integration simpler via the communication link approach. In addition, having similar components at both vendor-provided control system and plant SCADA system would be ideal since maintaining similar systems is easier. In real world, most vendors offer their standard control system package. Design should specify integration methods and provide proper directions in the event of mismatched PLC manufacturers and communication protocols.

![Multi-Vendor Package Control System Interface with Plant SCADA for City of Weslaco, Texas.](image)

Most vendors provide the standard protocol as offered by the PLC manufacturer in their control system. Design documents should clearly state the party responsible for providing the required
protocol converters during construction in the event of a protocol mismatch. This information should be included in the vendor equipment specification section as well as the sections responsible by the system integrator. In the event of different OITs between the vendor and other areas of plant, proper operator training of the OITs should be specified.

- **Monitoring and Control signals**

During the integration process, an accurate list of monitoring and control I/O signals is necessary for a complete interface between the vendor-provided control system and plant SCADA system to achieve the desired process control. Non-availability or an incomplete list of I/O signals in design leads to additional time and budget spent during construction to determine the complete I/O interface for the intended remote monitoring and control operation. This effort may sometimes lead to revisiting the process control philosophy and re-designing the remote monitoring and control of the equipment since a complete I/O was not planned ahead thus resulting in delays at multiple levels and added cost.

Based on the results of control philosophy coordination with the vendor, necessary I/O for remote monitoring and control from plant SCADA should be discussed between the process engineer, vendor and end user. The I/O availability for interface between vendor-provided control system and plant SCADA system in the form of established communication protocol such as hardwired, communication link, or a combination of both, should be coordinated.

![Figure 5. Typical Electrical Schematics from Vendor Package System showing Hardwired Signal connections available for Plant SCADA.](image)
If hardwired approach is desired, the number of I/O and the type (Analog I/O, Digital I/O) should be coordinated with the electrical engineer so that proper conduit and wire counts are specified. End user should be consulted for preferences in monitoring certain parameters from vendor-provided control system such PLC diagnostics and cabinet intrusion alarms.

<table>
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<tr>
<th>Address</th>
<th>Type</th>
<th>Description</th>
<th>On State</th>
<th>Off State</th>
<th>Function</th>
</tr>
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<tbody>
<tr>
<td>TBC</td>
<td>BOOL</td>
<td>All Blowers Failed</td>
<td>Failed</td>
<td>Not Failed</td>
<td>Status</td>
</tr>
<tr>
<td>TBC</td>
<td>BOOL</td>
<td>Pressure Instrument Status</td>
<td>Healthy</td>
<td>Failed</td>
<td>Status</td>
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<tr>
<td>TBC</td>
<td>BOOL</td>
<td>Blower Group Service Status</td>
<td>In Service</td>
<td>Out of Service</td>
<td>Status</td>
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<tr>
<td>TBC</td>
<td>BOOL</td>
<td>Forced Duty Changeover Control</td>
<td>Enabled</td>
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<td>Demand Mode Actual</td>
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<tr>
<td>TBC</td>
<td>INT</td>
<td>MCP Watchdog Counter</td>
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<table>
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<th>Address</th>
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<td>Blowers Speed Reference</td>
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<td>TBC</td>
<td>REAL</td>
<td>Current DO Setpoint in Use</td>
<td>mg/l</td>
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<td>Status</td>
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<tr>
<td>TBC</td>
<td>REAL</td>
<td>Average DO Value</td>
<td>mg/l</td>
<td>0.1</td>
<td>Status</td>
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<td>Aeration Zone 1 DO Value</td>
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<td>Aeration Zone 2 DO Value</td>
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<td>REAL</td>
<td>Aeration Zone 3 DO Value</td>
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<td>Aeration Zone 4 DO Value</td>
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<td>Aeration Zone 6 DO Value</td>
<td>mg/l</td>
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Figure 6. Typical list of Monitoring Signals from Vendor Package Control System via the Communication link.

A list of I/O for monitoring and control as required should be developed, indicating the type, and interface method, whether hardwired or communication link. If communication link method is used, the I/O list may be combined with the memory map information that is discussed below. It is good practice to exchange the documented I/O based on coordination between the vendor and end user during the design phase.

- **Memory Map and Tagging Scheme**

For full integration of the vendor-provided control system with the plant SCADA system via a communication link such as Ethernet based protocol, memory map information is required. The memory maps define the PLC register addresses for each I/O transferred between the two systems. If the memory map information is missing or incomplete, more time and money may be spent in configuring the plant SCADA system at the field for remote monitoring and control of the vendor equipment. If the design specifications do not require the vendor or the system integrator to exchange memory maps information and perform coordination in a timely manner, an opportunity to plan ahead on the communication logic development and identification of potential issues and troubleshooting is missed.

During design, confirm with the vendor an electronic copy of vendor system PLC configuration that includes memory maps of I/O being monitored and controlled remotely from plant SCADA, would be made available for exchange with the system integrator. Specifications should require
the development of memory maps by the vendor that define PLC register locations for each analog and digital data transferred between the vendor PLC and the plant SCADA system. Memory maps should include register addresses or the tag name, and description of information available in the register. In addition, memory map submittals should include data type of signals, engineering units for analog signals, and alarm type (such as warning or failure for the discrete signals). The tagging scheme for a list of interfacing I/O between the two systems should be coordinated between the system integrator and the vendor. The system integrator and vendor should work together and evaluate simpler ways to map the tags. The maps should be efficient in the context of making future changes to the tags that could easily propagate between the two systems without involving significant configuration efforts needing additional time and budget. The design specifications should call for exchange of the tagging schemes submittal and agreement certifications between system integrator and vendor prior to developing the application for the project.

<table>
<thead>
<tr>
<th>Item</th>
<th>Description</th>
<th>Type</th>
<th>Plant PLC Tag</th>
<th>Input Address</th>
<th>PLC Address</th>
<th>Raw Range in PLC</th>
<th>Scale</th>
<th>Scale Divide</th>
<th>Alarm Type</th>
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<tr>
<td>1</td>
<td>Inlet Bearing Vibration</td>
<td>Integer</td>
<td>AS_VIBR1</td>
<td>L1.1</td>
<td>N1.1</td>
<td>0-500</td>
<td>0.1</td>
<td>0-100</td>
<td>Infrac</td>
</tr>
<tr>
<td>2</td>
<td>Outlet Bearing Vibration</td>
<td>Integer</td>
<td>AS_VIBOR1</td>
<td>L2.2</td>
<td>N2.2</td>
<td>0-500</td>
<td>0.1</td>
<td>0-100</td>
<td>Infrac</td>
</tr>
<tr>
<td>3</td>
<td>Inlet Bearing Temperature</td>
<td>Integer</td>
<td>AS_TEMPM1</td>
<td>L2.0</td>
<td>N2.4</td>
<td>Straight Scale</td>
<td>Straight Scale</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Outlet Bearing Temperature</td>
<td>Integer</td>
<td>AS_TEMPO1</td>
<td>L2.1</td>
<td>N2.5</td>
<td>Straight Scale</td>
<td>Straight Scale</td>
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<td>5</td>
<td>Inlet Air Temperature</td>
<td>Integer</td>
<td>AS_TEMPA1</td>
<td>L2.2</td>
<td>N2.6</td>
<td>Straight Scale</td>
<td>Straight Scale</td>
<td>1</td>
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<td>6</td>
<td>Discharge Air Temperature</td>
<td>Integer</td>
<td>AS_TEMPO1</td>
<td>L2.3</td>
<td>N2.7</td>
<td>Straight Scale</td>
<td>Straight Scale</td>
<td>1</td>
<td></td>
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<td>7</td>
<td>Motor Inlet Bearing Temperature</td>
<td>Integer</td>
<td>AS_TEMPM1</td>
<td>L3.0</td>
<td>N3.6</td>
<td>Straight Scale</td>
<td>Straight Scale</td>
<td>1</td>
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<tr>
<td>8</td>
<td>Motor Outlet Bearing Temperature</td>
<td>Integer</td>
<td>AS_TEMPO1</td>
<td>L3.1</td>
<td>N3.7</td>
<td>Straight Scale</td>
<td>Straight Scale</td>
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<td>9</td>
<td>Inlet Valve Position Feedback</td>
<td>Integer</td>
<td>AS_POSBF1</td>
<td>L4.1</td>
<td>N4.7</td>
<td>0-1000</td>
<td>0-100c</td>
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<td>10</td>
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<td>AS_POSCMP</td>
<td>L4.0</td>
<td>N4.9</td>
<td>0-1000</td>
<td>0-100c</td>
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<td>11</td>
<td>Discharge Pressure</td>
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<td>AS_PRESS1</td>
<td>L1.5</td>
<td>N2.2</td>
<td>0-200</td>
<td>0-20 psi</td>
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<td>12</td>
<td>Surge Vanning Demand</td>
<td>Integer</td>
<td>AS_SGSPV1</td>
<td>N/A</td>
<td>N/A</td>
<td>0-500</td>
<td>0-50 Amps</td>
<td>10</td>
<td></td>
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<td>13</td>
<td>Surge Alarm Setpoint</td>
<td>Integer</td>
<td>AS_SGSPA1</td>
<td>N/A</td>
<td>N/A</td>
<td>0-500</td>
<td>0-50 Amps</td>
<td>10</td>
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<td>14</td>
<td>Overload Varning Demand</td>
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<td>AS_LOSPV1</td>
<td>N/A</td>
<td>N/A</td>
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<td>10</td>
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<td>15</td>
<td>Overload Alarm Setpoint</td>
<td>Integer</td>
<td>AS_LOSPA1</td>
<td>N/A</td>
<td>N/A</td>
<td>0-250, 0-200</td>
<td>10</td>
<td></td>
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<tr>
<td>16</td>
<td>Local Amps Setpoint Command</td>
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<td>AS_CURSPI1</td>
<td>N/A</td>
<td>N/A</td>
<td>0-250, 0-200</td>
<td>10</td>
<td></td>
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</tr>
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</table>

**Permissives**

Often times, permissives are implied in the overall control description of a process system, and not clearly stated in a separate section in the design documents. It may not always be clear to the programmer that a permissive is required to start or stop the equipment. This leads to undesired control scenario where equipment operation is not the way design intended. Additional time and budget is spent in troubleshooting the issues as a result of missing permissives and could delay the progress in field testing and start-up.
Permissives should be clearly defined in the design documents referencing the sequence of operation. List all applicable permissives for a process equipment to be interfaced with the vendor system. The information should include origin of the permissive generated. Whether the permissive is generated by plant SCADA system based on input from a measuring device (such as rising level above a setpoint) or generated internally when a series of conditions are met. Permissives should relate to the plant process conditions and state the course of action when the conditions are met.

- **Fail-safe Conditions**

In presence of certain permissives, proper fail-safe conditions should be defined. In the absence of fail-safe conditions in design, undesired effects in process control and could result in equipment failure or even damage costing huge sums of money for the facility.

Fail-safe conditions should be coordinated during design with the vendor with careful considerations on different failure scenarios. In the event of loss of signals or permissives due to either of the systems PLC failure or a communication link failure, fail-safe conditions such as valve close/open, pump shutdown should be defined.

- **Alarms and Faults**

Alarms and faults are often not completely defined in the design documents, especially on projects where large numbers of I/O and complex controls are involved. On many occasions, alarms and faults become “punch list” items in the field during testing in the presence of end user and design engineer, with system integrator or the vendor programmer having to spend additional man hours and budget to meet the desired notifications to operator.

Consult the facility personnel during design coordination for alarms and fault display requirements on the screen. Coordinate with the vendor during design about the necessary and desired alarms and faults. Considerations should be given on where the alarms and faults should be displayed, whether on vendor-provided control system OIT or plant SCADA system HMI or on both. List the necessary and desired alarms and faults in the design documents. In addition, alarm acknowledgement or fault reset location should be defined, whether they are acknowledged at the vendor control system OIT and or at the plant SCADA system HMI.

**GENERAL REQUIREMENTS**

While developing the design specifications, submittal exchanges, coordination meetings and testing requirements should be well defined taking into account of all potential issues and conflicts during construction.

- **Submittal Exchanges**

To facilitate full integration of the vendor-provided control system into plant SCADA system, require in the design specifications for the vendor to exchange supplied package control system...
submitting with the system integrator. The system integrator should review the vendor-provided control system and provide comments within a specified time frame. The vendor should address all comments and provide certification that coordination is complete prior to forwarding the submittal to the engineer for review. In a multi-vendor package system, the specifications should require the representative vendor take responsibility for the entire system. The representative vendor should coordinate and exchange submittals with the other vendors who supply auxiliary equipment to the overall package control system.

The specifications should list major items that require the vendor to coordinate with the system integrator during submittal exchanges. Items that require due diligence subject to particular application are listed below:

- **End User Standards** – Existing standards if any at the facility that needs to be followed for developing any tagging or programming of control system components.

- **Control System Components** – Manufacturer datasheets for PLC, OIT, Network switches, cables with model numbers.

- **Communication Link** – Matching protocol or use of protocol converter for data transfer to plant SCADA system.

- **I/O List** – I/O type, rack no., slot no., point no., description, loop no., range/setpoints, engineering units, specification/drawing reference. This list may be combined with the memory maps described below.

- **Memory Maps** – Vendor PLC register addresses for all I/O interfaced with plant SCADA, data type of I/O, Tag name, I/O description, Range and units.

- **Control Description** – A narrative of the sequence of operation of all equipment controlled and monitored with permissives internal to the vendor-provided control system.

- **Permissives** – A list of permissives that need to be transferred to plant SCADA.

- **Fail-safe Conditions** – A narrative of how fail-safe conditions are met.

- **Alarms and Faults Display** – A list of alarms and faults that will be displayed on the Vendor system OIT and a separate list to interface with plant SCADA for remote monitoring. The information should include location of alarm acknowledgement, whether at the vendor-provided control system or at the plant SCADA.
• **Coordination Meetings and Workshops**

Require in the design specifications for system integrator and vendor to hold periodic coordination meetings as necessary to discuss the results of submittal exchanges. In addition, require the system integrator and vendor to participate in graphics workshops to coordinate on the graphics development for vendor system OIT and graphics to be mimicked in plant SCADA system HMI. The workshop is intended for the programmers on both systems to gain familiarity with existing facility standards such as color conventions, and to match graphics layout on both systems to the maximum extent. This requirement is intended to avoid the end user having to use two different graphics design for daily operations.

Additional coordination meetings between the vendor and system integrator may be required depending on the size of the project. Topics may include coordination on field functional demonstration testing once fully integrated. Coordination meetings offer an opportunity to plan and discuss the execution of testing, and identify potential issues. Early approach to resolving problems in the factory will be more economical than realizing the issues in field which could result in additional field trips and related expenses.

• **Testing and Start-up**

The objective of testing phase is to test thoroughly the vendor-provided control system that is integrated with the plant SCADA system as one system and achieve desired process control. Specifications should require at minimum, unwitnessed factory testing, and a witnessed field functional demonstration testing before the startup. The benefit of UFT is to test equipment for performance and quality control in a simulated field environment and identify and troubleshoot issues prior to testing in the field. The goal of FDT is to connect the vendor-provided control system with the plant SCADA system, test communication between the systems, test for proper operation of the control strategy, permissives, fail-safe conditions, and alarms and fault displays, in presence of design engineer and end user of the facility. The FDT should be required to demonstrate vendor equipment and control system that are furnished are properly installed and they follow field quality control procedures.

The specifications should require the system integrator and vendor to work together during the field testing and start-up operations. In cases where a multi-vendor package system is provided, the representative vendor should be required to take responsibility for all coordination of the testing procedure with system integrator.

**FURTHER RECOMMENDATIONS**

Preliminary indications from the referenced case study projects in Figure 3 and Figure 4 have suggested early coordination efforts between the vendor and system integrator and taking early attempts to resolve major issues. As of this writing, projects in the case studies are under construction, and full benefits of the design approach have not been completely realized. Even so, there can be no doubt the approach discussed is worth the effort during design in minimizing issues down the road as it leads to
early coordination attempts and resolution of major issues before taking the field. In minimizing delays
due to early approach to resolving the major issues, added value to this design approach is controlling
costs which may have been incurred if problems with integration were identified in the field.

The approach to improving effective design of the vendor-provided control system never ends. Here are
some more steps to consider in reducing delays and costs in the field startup phase:

- Consider requiring the vendor to submit a project plan describing how the work will be executed
  complying with design specifications. Require the vendor to provide any deviations and
  exceptions to the specifications. This is beneficial in identifying potential issues due to deviation
  from the design intent early in the construction, allowing steps to be taken early to resolve
  issues.

- Consider requiring additional testing such as witnessed factory testing of the vendor-provided
  control system integrated with plant SCADA system at a chosen common staging facility. Consult
  the end user if personnel from their facility would prefer to be present at the WFT. Require the
  testing be witnessed by the engineer and end user if possible. This is beneficial with respect to
  identifying issues early with testing in the closest possible “real world” environment outside of
  the factory. Major potential issues such as communication link between two systems can be
  identified early and maybe be overcome.

- Consider requiring the system integrator to provide IP addresses or an addressing scheme to the
  vendor programmer during application development stage for connecting the vendor-provided
  control system to plant SCADA network. The IP addressing scheme should be coordinated with
  the facility IT personnel. This is beneficial in avoiding delays to field functional demonstration
  testing and making additional field trips to update the software application and reload in the
  PLC or OIT.

CONCLUSION
In the past vendor package systems were viewed as a “black box” since the operators did not necessarily
understand how the controls inside the package system worked due to limited data seen remotely from
plant SCADA systems. This lack of information and clarity may be due to limited technological
capabilities in the integration process or the lack of an effective design approach. With an effective
design approach in integrating the vendor-provided control system within the plant SCADA system, and
advancements in networking, there will be increased clarity in the inner functionalities of the package
system. Operators can access vendor package system data from any location with the SCADA HMI
access. Vendor system data can be easily included in the plant’s historian, trending and reporting. With
effective design approach and early coordination efforts, a seamless integration can be achieved within
budget and on schedule.

List of Acronyms:
HMI..................Human Machine Interface
I/O ....................Input / Output
OIT ................... Operator Interface Terminal  
PLC ................... Programmable Logic Controller  
SCADA .............. Supervisory Control and Data Acquisition  
UFT .................. Unwitnessed Factory Test  
FDT .................. Functional Demonstration Test  
WFT .................. Witnessed Factory Test

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