Economic Impact of Digital Technology

on

Wet Scrubber Construction

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Executive Summary

Study Scope

This study compares implementations of a Distributed Control System (DCS) on a Greenfield or retrofit wet FGD installation. The “Traditional” installation utilizes dedicated cables to hardwire non-intelligent field devices to input/output (I/O) cards. The Digital Bused Plant (Bused) installation uses bused I/O, high speed field communications networks, and intelligent or “smart” field device technology to simplify construction. Costs were estimated for both implementation approaches in five categories: system selection, engineering, construction, startup, and overheads.

Implementation

General arrangement (GA) drawings for a 600 MW power block and a three-stage emissions control systems block including the FGD were developed. Remote buildings and auxiliary systems were dimensioned to allow development of accurate project design and construction estimates. An actual project DCS I/O specification was partitioned into system designations, resulting in a total base configuration of 2,678 hardwired I/O points. The base configuration of the FGD module included the following auxiliary equipment:

- Two booster fans for the absorber module
- Four recycle pump trains for the absorber module
- Two ball mill trains in the limestone prep area
- Two dewatering trains for the plant site

Two selection methods were defined to purchase a system. The Traditional approach utilized an Engineer, Procure, Construct (EPC) model with a detailed specification, bid, and evaluation process. The Bused approach used a model called PEpC with similar, re-ordered activities: Procure strategic suppliers, Engineer, procure balance of plant, and Construct. The PEpC selection process partially eliminates the expense of a complex specification and bid process. Costs associated with the EPC and PEpC selection process were identified and estimated. The savings available via the PEpC process are effectively equal for either the Traditional or Bused approach and have been included for reference.

DCS implementation strategies were developed for both approaches, including system configuration and field I/O interface methodologies. The Traditional strategy used a system of tray and conduit to route individual I/O cables from a field device to a DCS cabinet. The Bused approach used two types of field I/O networks and a combination of hardwired I/O to interface with smart field devices. The networks include control and temperature (data acquisition) analog I/O, and digital I/O segments. In the Bused approach, Sequence of Events (SOE), non-smart analog, and high speed process loops were hardwired to I/O cards using traditional methods.

Construction design criteria were also developed for both approaches, including labor costs, tray, conduit, and cable lengths and material costs. Individual design parameters were assigned to all I/O points in the study to complete the construction estimate. Device upgrade costs for smart transmitters, digital I/O, and intelligent motor interfaces were estimated for the Bused approach as an adder to traditional costs.

Plant checkout and startup tasks and time estimates were defined for each I/O type. Potential critical path schedule savings were estimated based on the difference in checkout and firing time for both approaches.

A plant construction schedule and budget were created to estimate total spending. From this, a construction financing methodology was developed to estimate interest during construction (IDC), which is the cost to borrow money to build the facility. Inflationary escalation was estimated based on typical utility accounting methods.

Fixed overhead costs were assigned to all construction and startup line items, and included administrative and general support, construction management, contingency, contractor indirect charges, freight, project management, spares, and sales tax. Variable overheads included inflation escalation and interest during construction at an annual rate of 3% and 6% respectively, both compounded calculations. Inflation effects were considered to start at project conception while IDC began with construction.

Where applicable, costs were split between analog and digital applications. Labor and material costs were also split to allow appropriate overhead allocation. In cases where analog/digital splits were not possible, costs were proportioned by total number of points.

Analysis

The wet FGD project construction estimate for the two installation methods are summarized in the following table. Approximately $3.9 million is potentially saved when utilizing the Bused approach on the base installation, a 49.6% total reduction in considered costs.

Item	Traditional	Bused	Total Delta	Percent
System Selection	$ 395,530	$ 135,506	$ 260,024	-65.7%
Engineering	$ 1,093,750	$ 429,083	$ 664,667	-60.8%
Construction	$ 2,989,797	$ 1,553,226	$ 1,436,571	-48.0%
Startup	$ 244,274	$ 110,952	$ 133,322	-54.6%
Subtotals	$ 4,723,351	$ 2,228,768	$ 2,494,584	-52.8%
Overheads	$ 3,038,788	$ 1,686,774	$ 1,352,015	-44.5%
Totals	$ 7,762,140	$ 3,915,541	$ 3,846,598	-49.6%

The following metrics were subsequently developed from estimated study costs.

Metric	Traditional	Bused	Delta	Percent
Total Cost	$ 7,762,140	$ 3,915,541	$ 3,846,598	-49.6%
Construction Cost per Point	$ 2,898	$ 1,462	$ 1,436	-49.6%
As a % of Total Plant Cost	9.41%	4.75%	4.66%	-49.6%

Use of the Bused approach may also allow O&M staff reduction due to high levels of automation and ease of troubleshooting. Use of other data evaluation and preventive maintenance packages may help prevent forced outages and increase plant efficiency due to high performance of well-maintained field elements.

Observations

Significant project savings were identified in all areas evaluated. The high percentage of digital I/O and motor services resulted in higher savings than in other applications with more analog I/O. Use of the PEpC selection process will result in an earlier entry for the project engineering team, requiring procedural changes to a typical project cycle. A strong owner and supplier presence may also be required to assist other development process stakeholders during a Bused project.

Implementation of a bus based I/O structure results in approximately a 40% reduction in the number of hard terminations while providing additional data. Intelligent field devices deliver multiple process signals, health status, and additional information simply not available using traditional hardwired methods and non-smart devices. For example, while traditional technologies provide a single data point for each field cable run, digital bus technology provides many measurements from each device through a single cable. The following table demonstrates the relationship between device terminations and information points in both approaches.

System	Hardwired Field Device Terms	Bussed Field Device Terms	Total Control/Data Points Available
Traditional	2,678	0	2,678
Bussed	132	1484	>10,000

Conclusion

The Bused implementation concept as specified in this study resulted in nearly 50% savings in selection, engineering, construction, startup, and overheads savings for base FGD unit costs considered. Challenges will include convincing development stakeholders to risk using new technology, marketing a new concept to a wider audience, and supporting project implementation using new methods. Use of this study as a reference to will help lead to a successful implementation of the Bused approach as an industry leading standard for large scale Greenfield and retrofit efforts.