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Unified control system in power plant – TCE approach for implementation in Indian context

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Abstract: This methodology of Unified controls for a Power plant is conceived by the consultants and EPC contractor to reduce life cycle costs. Our approach is designed in such way to reduce the upfront engineering time also. The engineering is to be integrated from various Utility OEM inputs and practices. This is implemented in few projects and various options are also indicated in the methodology.

Keywords: Unified control system, DCS, Power plants, Utility packages.

I. INTRODUCTION

The advent and application of new technologies in information technology have triggered a continuous improvement and development in automation system solutions and control system architecture. However - industrial automation, especially power plant automation has a relatively conservative approach with respect to fast changing trend in automation hardware, software & communication.

The 1st generation plant digital control systems had microprocessor based single loop controllers integrated into BTG unit control boards with HMI for user interface.

The 2nd Generation digital control system in 1990s evolved all control functions with proprietary communication protocols.

The current 3rd generation DCS controllers use PC technology with open architecture & OPC compliant 3rd party hardwired interfaces.

With advancement in technology, especially in concept of communication protocols to facilitate interfacing different control systems, the concept of implementing unified plant environment has been possible to the extent in power plant control systems. These systems are network enabled and fast becoming communication channels that provide real time information as inputs to all decision makers and increase awareness in management. Wireless technology, fiber optic network, field bus & client server based architecture have added to these improvements.

Table- 1 indicates different automation levels to achieve Unified Automation Integration for Power Plant. As indicated in Table -1, plant automation has two categories, one is process automation and other is power or electrical automation i.e. substation automation. Due to the fact that many protocols are used in "Substation automation", today integration ofelectrical equipment is a challenge.

However, a few DCS manufacturers also deal with protection and control of electrical systems and are in a position to completely integrate DCS and electrical SCADA functions.

Around 1998, agencies like IEC & IEEC joined together and introduced a open protocol usable by all leading manufacturers i.e. IEC 61850 exclusively for interface of electrical SCADA functions with power plant process control systems .

Process automation also has 2 areas i.e. Process instrumentation and process or electrical electrification. Generally in process electrification all critical electrical drives are connected via hard wiring I/Os (Input /Output). Latest trend is to have few non-critical electrical breaker controlled drives control from DCS by integrating Smart MCC (motor control centre) in seamless manner through IEC 61850 or profibus protocol. For utility packages like water treatment, plant integration is done for all electrical devices by using smart MCC i.e. soft link is used instead of regular hardwiring of electrical signals in few projects.

Next area as shown in Table-1 is automation of main plant equipment and Utility packages like CHP, AHP, WT Plant, etc. Generally, control of utility packages are implemented in PLC, since it is cost effective and does not require complex control functions .

In India, most power plant designers have conservative approach, hence the technological improvements and unified controls automation for the complete plant at all levels of process and electrical automation implementation is yet to be achieved in totality.

However in recent years ,few clients prefer to implement controls of these Utility packages in unified plant control system. Seamless integration of DCS for main plant and utility packages have many advantages to end users like improved operator effectiveness, reduced maintenance costs, lower life cycle costs, etc.

As noted above, many clients are implementing DCS controls for main plant control and also utility packages controls . The issues to be overcome for implementation of the same are :

a) Single EPC tender for complete plant are not preferred due to cost optimization.
b)In power plants, main BTG equipment and respective packages supplier are separate & are specialized vendors.

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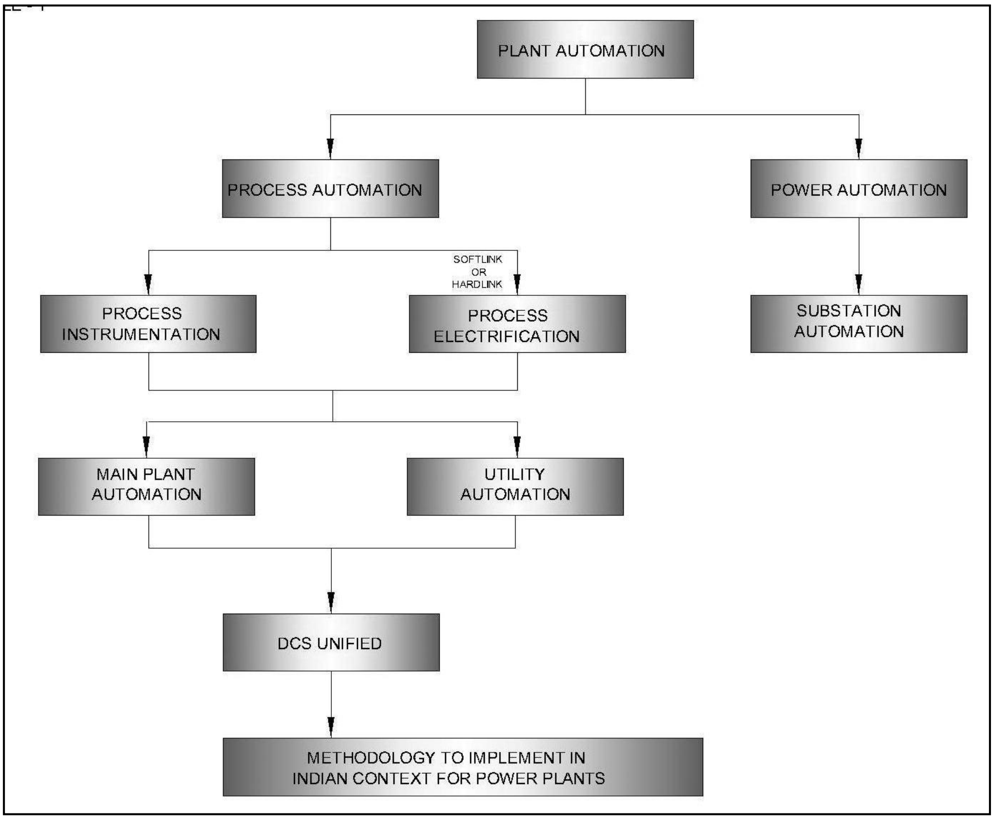
TABLE-I



So usually independent tenders are floated to get the cost benefit and interface between all packages and main BTG plant is done by client/consultant.

c) Schedule of implementation could be a deterrent , since utility packages are ordered after getting inputs from Main BTG Plant.

To implement concept b) above , upfront a lot of Engineering Documents/interfaces of package units are to be included in DCS tender documents, generally a part of main plant BTG package. These engineering documents are prepared with existing data base and experience to facilitate initial tender purpose engineering. Validation and approval is done after the receipt of input from respective vendors during detail engineering phase.

II. METHODOLOGY

A. Case Study – 1

- Control/ Operation philosophy of the complete plant to be conceptualized and finalized.
- In consultation with client, finalize and include Control System for entire plant in BTG package contract. A separate tender for C&I including the control systems for main plant DCS & utility packages.
- After review of basic studies of respective packages, prepare engineering documents: I/O List, Drive Control Philosophy, Location, No. of Operator / engineering stations, LVS using available data bank as a preliminary estimation. However all these details shall be reviewed and approved after receipt of the respective vendor information.
- Detail unit prices are requested in tender for facilitating the minor variation, if any in quantities of hardware vary during detail engineering the system.

After the placement of order for DCS, the following steps are followed,

- DCS vendor shall configure the system by finalizing functional grouping of controllers, location of remote control cabinet / I/O Cabinets, location of operator work station (HMI's) based on operation philosophy of the plant (Typical attached Table - II)
- Engineer the control cabinets as per I/O list (Typical attached Table - III), Instrument List, Drive philosophy provided by respective vendor of package and reviewed by the Client /Consultant.
- Incorporate the Control logics and Graphic pages as submitted by the respective vendors after Client / Consultant approval.
- Regular Technical Interaction meetings are held between Respective Vendor /DCS Vendor/Client/Consultant
- After engineering completion, FAT of the package supplier respective control system shall be conducted with Engineers of the package supplier and Client / Consultant Engineers.
- Complete Cabling up to marshalling cabinet of Control system shall be done by respective package supplier from primary source i.e. field input under the supervision of DCS Vendor.
- Commissioning of systems shall be done jointly by DCS Vendor and respective package supplier under supervision of owners' engineers.

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TABLE – II OPERATION AND CONTROL PHILOSOPHY FOR THE UTILITY PLANTS IN THERMAL POWER PLANTS FOR 660MW CAPACITY.

SL. No.	System / package	Location of control system	Control room Hardware	Interface with sub systems	System supplied to
1.	Coal Handling Plant (CHP) (Common for all the units)	CHP control room	Redundant controllers Dedicated IO Modules and cabinets Remote IO modules and cabinets 1 No- EWS , 2 No- OWS 1 No- LVS (67 “) 1 No-A3 cum A4 laser colour printer	Remote I/Os	CHP package vendor
2.	Ash handling plant (AHP) (Common for all the units)	AHP control room	2 sets of Redundant controllers Dedicated IO Modules and cabinets Remote IO modules and cabinets 1 No- EWS, 2 No- OWS 1 No- LVS (67 “) 1 No-A3 cum A4 laser colour printer	Remote I/Os	AHP package Vend or
3.	Water Treatment Plant(includes Pre -Treatment Plant +DM Plant + CW treatment + Electro Chlorination System + ETP + STP + RW Intake system+ CW makeup) (Common for all the units)	WTP Control room	Redundant controllers Dedicated IO Modules and cabinets Remote IO modules and cabinets 1 No- EWS 2 No- OWS 1 No-A3 cum A4 laser colour printer	Remote I/Os	WTP package Vendor
4.	Fuel Oil Handling and Storage (Common for all the units)	Fuel oil pump house	Redundant controllers Dedicated IO Modules and cabinets Remote IO modules and cabinets 1 No- EWS cum OWS	Remote I/Os	FOHS package vendor
5.	Air conditioning (HVAC) and ventilation system (Common for all the units)	Chiller Room	Redundant controllers Dedicated IO Modules and cabinets 1 No- EWS cum OWS 1 No-A3 cum A4 laser colour printer		HVAC package vendor

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6.	Hydrogen Generation Plant	Hydrogen Generation Plant control Room	**Redundant controllers** **Dedicated IO Modules and cabinets** **1 No- EWS cum OWS**		Hydrogen generation package vendor
7.	Miscellaneous For CW pumps , Cooling tower , compressed air system , COLTS etc	Main control room	**3 No- OWS (1 station at each location)** **1 No-A3 cum A4 laser colour printer**	Remote I/O or hardwired to nearest remote cabinet. (To be decided during engineering)	Owner .

TABLE – III TYPICAL I/ O COUNTS FOR BOP FOR THERMAL PLANT OF 660MW

Sr.No	System	DI	DO	AI	AO	Soft Interface
1	FOPH	135	70	55	20	Not required
2	CHP	650	225	25	5	Not required
3	AHP	1460	1300	150	0	Not required
4	ECP+DM+ETP	1675	900	305	30	Not required
5	HVAC	290	160	30	0	
6	Miscellaneous For CW pumps , Cooling tower , compressed air system , COLTS etc	300	50	50	50	Not required
7	Switchyard	30	0	10	0	redundant, Bidirectional OPC link
8	Fire Alarm	10	0	0	0	redundant, Bidirectional OPC link
9	Fire protection	0	0	0	0	Not required
10	DG set	8	0	0	0	Uni directional, Non redundant Mod bus link
11	EBOP-Electrical	1500	560	60	0	Modbus/OPC/IEC 61850
12	IEC 61850 E Bop interface	NA				IEC61850 SOFTLINK
13	UPS	20	0	5	0	Uni directional, Non redundant Mod bus link

B.Case Study - 2

- To place order on BTG contractor with Main plant DCS in BTG scope and utility plant controls system are excluded .
- Unit rates of all critical modules of DCS from DCS vendor to be obtained and instruct DCS vendor to use this price for all utility control systems engineered by respective package supplier.
- Float EPC specification for utility packages including respective control system. Mention in the specification that the control system should be of same make as that of BTG DCS.
- Earlier client selected DCS vendor get a separate order from CHP contractor, AHP contractor, etc. for the respective control systems.
- All required engineering is done by the respective package supplier & DCS vendor implements utility control system engineering in DCS.

C. Benefits for customer implementing case study-2 in comparison with case study -1

- No inputs (related to IO counts) with regard to utility plants had to be calculated by the customer / consultant & the entire responsibility of the respective engineering was left to the respective package suppliers.
- Customer need not have to check & make payment individually for each of the utility plant DCS control system as the cost is built in the respective package supplier scope.
- Successful implementation without any interfacing issues.

D. Benefits for customer implementing case study-1 in comparison with case study -2

- Uniformity of data presentation and operation procedure improves operation quality.
- Availability of operation graphics/ information from all work Stations.
- Collection of all data in one single data base.
- Simplified IT system administration like system security, back up procedure etc.,
- Simplified engineering documentation, reduced spares, low maintenance cost.
- Leads to single interface with plant information management, computer maintenance, management system (CMMS) etc.

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III. CONCLUSION

- Initially, it was felt that using DCS for all functions / pack ages could be costly, however in view of long term benefits noted above, unified DCS for the complete power plant would be cost effective.
- Also, uniform hardware is used for control system and use of remote I/O's for various plant areas reduce cabling cost.
- In areas of maintenance and spares, reduction in long run i.e. reduction in life cycle cost is achieved.
- We feel that client can adopt unified controls for the complete power plant. All required support and engineering shall be provided based on experience**.**

BIOGRAPHIES

Mr K. Jayaprakash is an Instrumentation & Controls Engineer with an Experience of 30 years in Power plant Engineering. Currently he is General Manager (I &C) for Power Business unit in Tata consulting engineers ltd. He was involved in Erection, commissioning & maintenance of Instrumentation & Control systems in Thermal power plant during his tenure in KPCL at Raichur Thermal power station.He was also involved in Design Engineering at KPCL – Bangalore for 13 years. He has engineered various Instrumentation & Control Systems for Thermal power stations ranging from 210MW to 500MW.

He was involved for 7 years in Erection, commissioning & maintenance of Instrumentation & Control systems in Thermal power plant during his tenure in KPCL at Raichur Thermal power station.In 2006 joined TCE as Deputy General Manager and worked in overseas group as design engineer & project manager till 2012. Presently holding the post of Discipline Head – Instrumentation – Power Unit.In TCE, he was involved in Engineering of I& C systems for Projects in Saudi Arabia, Oman, Kuwait, Australia Algeria, Nigeria & Zambia. He is also certified ISO auditor and certified TATA BUSINESS EXCELANCE MODEL Auditor and was Quality coordinator for 4 years for Bangalore operations.Academic Qualification B.E (Instrumentation) & M B A (Mktg) University of Bangalore.

Ms. M.Rukmani, Academic Qualification: B.Sc., B.Tech (Instrumentation) from Madras Institute Of Technology.She has around 22 years of experience in design & detailed engineering of power plant & DCS systems.She has engineered thermal power plant of sub critical, super critical power projects in TCE.She has hands on experience in DCS systems – Foxboro, ABB systems in her previous assignments with Foxboro & ABB. She has conducted extensive factory acceptance tests on Metso DNA & MAX DNA DCS systems & GE PLCs.

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