Harnessing the Power of IT for Improvement of Power Plant Performance

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Absract-**Traditionally information technology is used in the power plants as a tool to collect information on various plant parameters and utilise this information to monitor and control the plant operation. However, this has largely been confined within the physical boundary of individual plants. The vast potential of improving the overall plant performance and also bringing down the operation and maintenance cost of the plants by effectively utilising the O & M and diagnostic feedback available with different plants is relatively unexplored in India.**

This paper attempts to identify the potential areas where information technology can effectively be used to virtually operate a number of power stations as a single unit to improve the plant performance, plant availability and cost of plant operation.

The key measures which could be adopted to use information technology for the overall improvement of plant performance are on-line condition monitoring of equipment/systems, fault analysis, suggested remedial measures through in-built knowledge base/centralised expert service via web enabled data transfer system.

On a similar line, the spares inventory of individual power stations can be more effectively utilised and managed through a centralised spares inventory management system including a well defined spares exchange mechanism amongst various power stations.

Keywords-**CSIMS,MIS,PEM,RDBMS.**

I. INTRODUCTION

Modern power stations extensively use Information Technology (IT) along with state of the art control systems to operate the units efficiently and safely. The operator in a power plant can access all plant data, control all equipment, view alarms and check performance and trends from a central control room. All the process requirements are well built in the control systems to ensure safe operation and monitoring of the plant. In recent times, it has also been used as Management Information System (MIS) which is an on-line information domain supported by the Distrubuted Control System (DCS), to provide basic plant parameters and computed performance related data like plant efficiency, boiler efficiency, turbine cycle efficiency, fuel consumption, emission of pollutants, cost of generation etc., in a single window for the plant managers. However, a lot more could possibly be done to exploit the vast potential of information technology to improve the overall plant performance.

Power generation companies in the country are facing new challenges due to deregulation which means increased competition, increased demands for cost-efficient operation and high plant availability. Hence, there is an immediate need to maximise the effective utilisation of resources available with the utilities. Thus a closer look at the possibility of further exploiting the vast potential of information technology to improve the overall plant performance may not be out of context

This paper attempts to investigate few of such potential areas where a better synergy between IT and power plants can enhance the performance standards in terms of plant efficiency, availability, safety and environmental conditions without being cost prohibitive. The paper also outlines the road map for implementation of the information system.

II. PRESENT PRACTICE AND SUGGESTIONS FOR IMPROVEMENT

Power plants of today employ state of the art DCS for efficient control and monitoring of the plant. MIS of the plants performs only the generation of performance reports by capturing data of the plant from the control domain. MIS stations are placed in strategic locations to enable viewing the performance of the plant. At plant level, some plants do have advance control products like boiler optimisation package linked to control domain to improve the performance of the plant. All the optimisation packages perform as stand alone packages improving the performance of specific equipment/process. However, at plant level there does not exist a comprehensive diagnostic system/tools to correct/alert the plant operators as and when such a need arise Planning of such a system backed by a core group of experts at plant level would be cost prohibitive. Therefore, a systematic coordinated approach in developing a knowledge base that will address all the issues related to plant performance and sharing such knowledge amongst the power stations through networking will surely provide a boost to the current plant performance level.

Also a centralised spares inventory management system that acts as a virtual centralised spares inventory of all the power stations and allows the spares to be shared by the power stations of a single owner situated at different locations could

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bring down the spares inventory cost of individual power stations while increasing the spares availability thereby effectively improving the bottom line of the utility company.

The key areas, which could be adopted to use information technology to address the above issues for the overall improvement of plant performance, are:

- On-line condition monitoring of equipment/systems performances against benchmark data, fault analysis and suggested remedial measures to plant operators.

- On-line transfer of data on plant performance, equipment/systems condition, measures taken by plant operating staff etc. from various power stations to a centralised location via web enabled data transfer system. This data on overall performance of the individual power units/stations could be reviewed by a group of experts and suggestions are given to the power stations, if required to improve the plant performance.

- Building a centralised database on causes for degradation of equipment/systems performance and equipment failure from various power stations and the remedial measures taken to rectify such faults. This data base would be available through web to all the participating power stations

- Establishing inventory management system with the help of a centralised data base linked with the spares availability in different power stations so as to minimise the inventory in individual power stations while maximising the availability of spares to all power stations through a process of spares exchange mechanism.

In view of the above it is necessary to develop a model to identify the key measures, deployment of tools, decision making environment and operator guidance messages for plant performance improvement On a similar line a second model is developed to improve the resource utilisation by way of spares exchange mechanism.

III. MODEL FOR OVERALL PLANT PERFORMANCE IMPROVEMENT

The model is based on the following:
- Available data from the plants
- Analysis of the data
- Identification of additional IT tools
- Development of knowledge base
- Generation of operator guided messages
- Mode of linking power stations
- On-line automated corrections to improve performance, wherever possible
- Remote monitoring and central control station
- Central database of plant performance

The data available in a plant control system shall be linked to the plant server located in the plant. The following data are proposed to be transmitted to the plant server:

- Equipment run-hours
- Equipment troubleshooting data
- Process parameters like pressure, temperature, level, vacuum, turbovisory parameters, etc
- Alarm summary, sequence of events record, reports and trends
- Computed values like boiler efficiency, turbine efficiency, heat rate, condenser performance, heater performance, etc.

The plant server hooked up to the DCS, shall be loaded with the Performance/Efficiency Monitoring (PEM) software and shall acquire on-line data from plant control system. It shall have the database of all the relevant tags required and shall include the following features:

a) Equipment health check data and troubleshooting measures (part of knowledge base)

b) PEM software package which shall be with the intelligence to provide on line comparison of the plant equipment and system performance related data vis-à-vis plant design data (corrected for actual conditions and aging) and provide on line corrections and operator guided messages (part of knowledge base).

The pre configured design data shall include :

- Equipment characteristics
- Equipment data sheets
- Cycle heat balance data under various site conditions and loads
- Benchmark data of all equipment/systems
- Process alarm and trip limits

Knowledge base is the nucleus of all the analysis to be carried out in the plant server. Developing the knowledge base is the most challenging task and needs the collective effort of power plant specialists from all disciplines. Knowledge base is a set of operator guided messages based on the cause-effect analysis. For a thermal power plant, all possible cause-effect conditions are to be considered to develop the operator guided messages. The operator-guided messages are to be configured in understandable form to the operator. The cause-effect analysis and operator guided messages are to be continuously compared with the plant behavior to post instantly the appropriate operator guided message to the plant operators. The knowledge base need to be reviewed periodically to update based on the feed back from the plant operators or from any other sources on unidentified and unexpected plant behavior and improvement in operator guided messages.

Fig.1, shows the flow chart to develop and use of knowledge base and to generate operator guided messages. The flow chart signifies the role of power plant experts in formulating the cause-effect matrix. The matrix must cover all anticipated disturbances in a power plant. As tagging is the backbone for the database development, tagging philosophy need to be defined while formulating the cause-effect matrix. Tagging philosophy shall be such that it starts from process/equipment

and ends with cause-effect along the flow path indicated. Flow chart also links the equipment/process design/guarantee data with the disturbances to generate the cause-effect matrix.

Plant server through equipment health check and through PEM station performs on a real-time basis the comparison of the present conditions with the residing plant design data and benchmark data to develop a deviation matrix. The deviation matrix is then compared with the residing cause-effect analysis to link the appropriate operator guided messages.

In addition to link the operator guided messages, the plant server prioritise the messages and accordingly transmit the same to plant operator stations.

The plant server must be designed to handle large amount of data, processing of data and generation of operator guided messages. Complete management of data is to be handled by a robust Relational Data Base Management System (RDBMS) package in the plant server. All the processing of data and generation of knowledge base shall reside in the plant server. The sizing of the server shall be based on the following:

- Size of data from the plant
- Size of plant design and bench mark data
- Processing speed of the data
- Speed of transmission to plant
- Speed of transmission to remote station

The plant control system should be securely connected to plant server to acquire the plant data at specified speed. All the associated communication interface and redundant data bus should be designed to meet the intended application.

Considering the scenario of group of power plants managed by a Utility company, the plant server of each station can be linked to a central remote station. The central remote station shall be located either in any one of the plants or at any other suitable location. The server of the central remote station shall be designed to acquire all the process information from the respective plant server. A core group of experts will be located in the central remote station who will continuously monitor and review all the linked plants parameters/performance They will offer their expert advices in case a particular plant operation is not in tune with the recommended mode or the built-in cause-effect analyses and operator guided messages do not adequately address the particular abnormality in equipment/system operation The central remote station shall be designed to perform the following tasks:

- Managing of health check data and process data from the linked power plants
- Generation of performance data of each linked power plant at defined intervals.
- Capability to generate trends and reports for each plant
- Generation of comparative performance data of linked power plants
- Ability to transmit operator guided messages to each plant based on the review and analysis, if required by the core group of experts.

Fig.2, shows the linking of respective plant server to central remote station.
The server of central remote station shall be sized suitably to perform the above-specified tasks. The operating software platform of central remote station shall be identical to the plant servers.

IV. MODEL FOR SPARES INVENTORY MANAGEMENT

The spares available at respective power stations shall be linked to a Centralised Spares Inventory Management System (CSIMS) which will act as a virtual common spares inventory of all the participating power stations. The requirement of spares not available in a particular power station would be checked with the spares available with other power stations and if found available could be exchanged through a well defined spares exchange mechanism.

The available spares list would continuously be compared with a benchmark data base of an ideal spares inventory and generate alarm list available to the central spares inventory manager and to the respective plant managers to take appropriate measures for procurement of spares in time.

The CSIMS through dedicated server shall be designed to perform the following tasks :

- Establish linkage to import/export data on spares availability with individual power stations
- Generation of centralised spares inventory database
- Comparison of available spares with minimum limit and generate alarm messages.
- Check availability of spares amongst linked power stations and inform spares inventory manager/power station managers

Fig.3, shows the flow chart of spares exchange mechanism

V. MODE FOR LINKING POWER STATIONS WITH CENTRAL STATION

The central remote station for performance improvement and/or for spares management may be linked to designated power stations in one of the following ways:

- Leased telephone lines
- Satellite telecommunication link

Considering the established countrywide telecommunication network and availability of service providers, the linking of power stations with central remote station is a definite reality. The specific bandwidth for transmission need to be arrived at so as not to interfere with other transmission bandwidths and also avoids possible noise based attenuation in the signals. The transmission links of the various participating plants have to be synchronized such that there are no collision of data.

VI. CONCLUSIONS

Linking of a group of power stations to act as a virtual single unit and creation of artificial intelligence through building up of a knowledge base to achieve the common goal of overall

improvement of power plants performance is a definite reality today. This is possible mainly because of the tremendous advancement in IT sector and development of an well established and reliable communication network spread through out India.

Initially networking of power stations could be limited to a single owner having number of power stations in different parts of the country. Once the concept and the mechanism of implementation is established within the fraternity of power generation, it could be expanded amongst a various utilities/power station owners and eventually it may perhaps be possible to cover all the power stations of India within its network.

VII. ACKNOWLEDGMENT

The authors are deeply indebted to TCE Consulting Engineers for their encouragement and help in preparation of this paper.

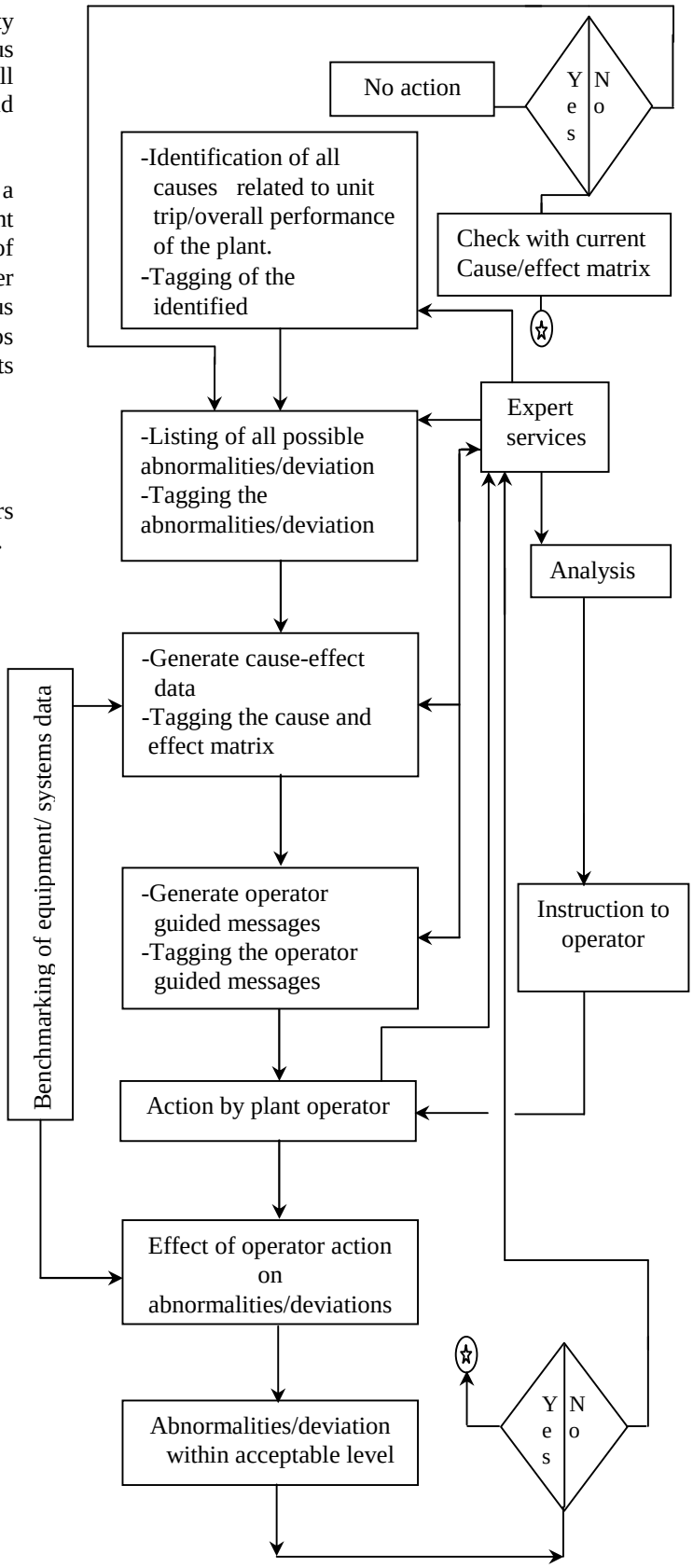

Fig 1: Flow Chart Showing Use of Knowledge Base and Expert Services to Improve Plant Performance

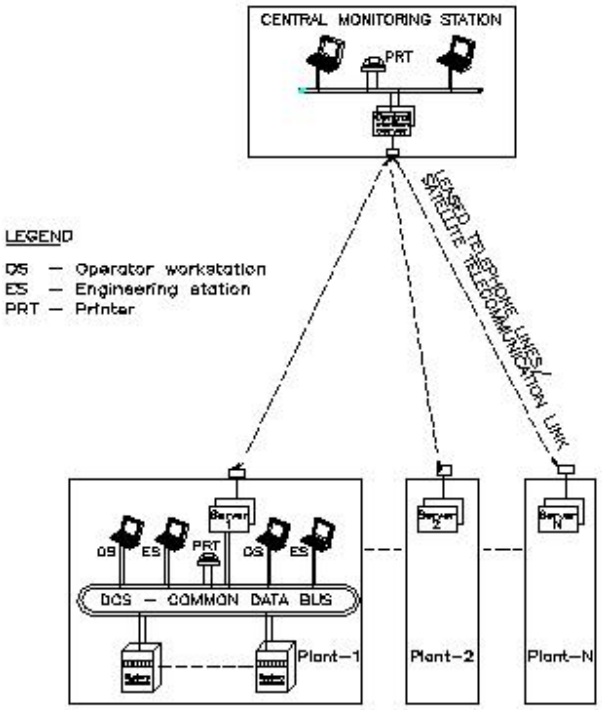

Fig 2 : Linking of Plant Servers With Central Remote Station

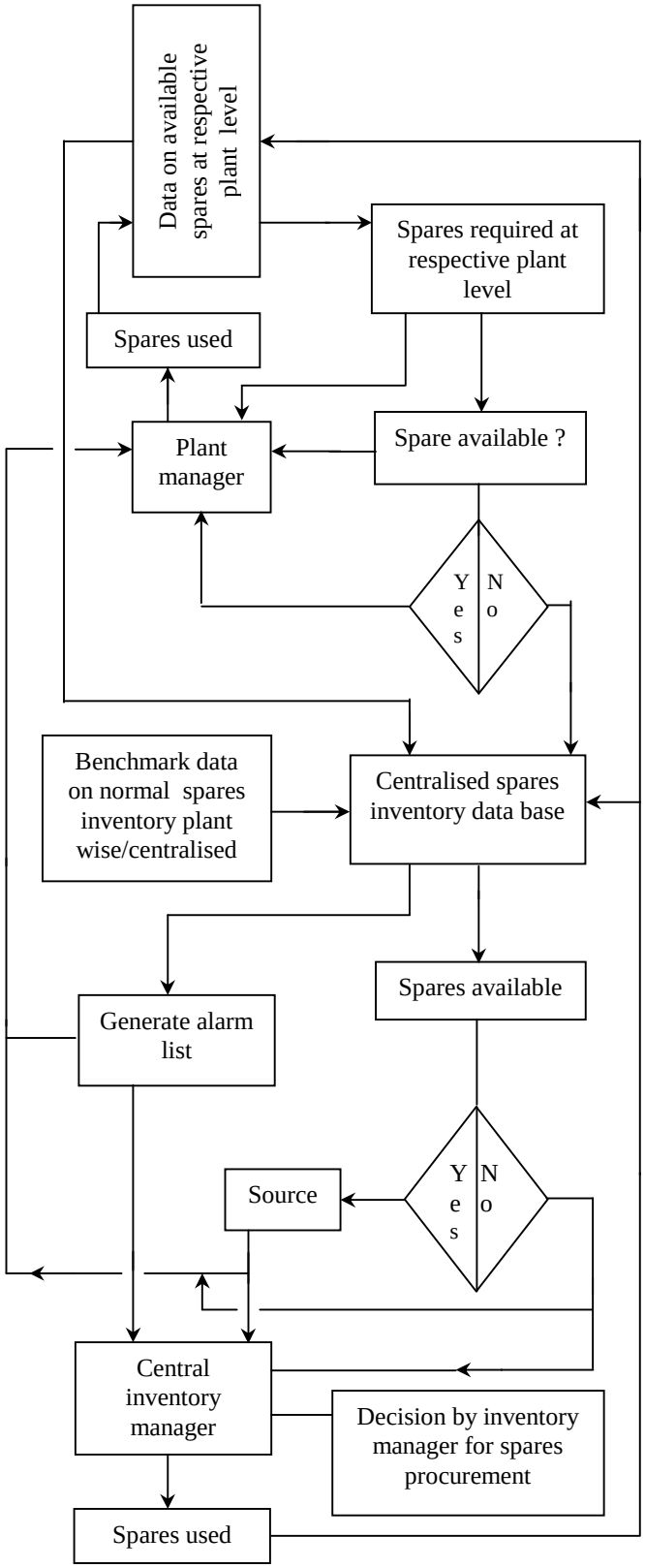

Fig 3: Flow Chart for Spare Inventory Management System