Technical Specification for Signal Validation Engine (SiVa)

Preamble

SiVa is a software platform to facilitate data validation/reconciliation of conventional thermal power plant processes. SiVa's high level architecture consists of two Modules; one based on VDI 2048 and process models and the other based on data centric approach using Artificial Neural Networks / suitable machine learning techniques. SiVa shall have to work in real time data available from plant DCS historian at pre configured intervals and validate all signals configured in its scope. SiVa shall typically consider measurements like mass flows, pressures, temperatures etc., and relevant derived parameters. SiVa shall operate on data when plant is in steady state operation and its range applies from 60% to 100% of rated conditions.

Scope of Development

Development includes S/W architecture, design, implementation, testing, and training at clients place. The following clauses apply to development.

Specs for development of Module I

1. Module I shall be designed based on VDI 2048 applicable to thermal power plants of 500 MW capacity.
2. Modeling of turbines, feed heaters, pumps, condensers, mills, fans, economizer, superheater, reheater, furnace and other heating sections of boiler etc., to suit the VDI formulation. The exact list of subsystems shall be selected during the course of development and the list shall be selected in such way that complete process cycle is covered. Constraint equations consisting of mass and heat balance and equipment characteristics etc., of entire cycle should be formulated in accordance with the requirements of VDI 2048 implementation.
3. Algorithms discussed in VDI 2048 shall be suitably modified as per requirements of entire cycle and BHEL's recommendations.
4. List of parameters considered for validation/reconciliation shall be configurable and they can consist of both measured and non-measured variables and redundancy in measured variables should be considered.
5. Probability distribution function for arriving at relevant requirements in VDI 2048, to be determined from historical data given by BHEL or any other formulation acceptable to BHEL.

Acceptance Criterion for Module I

1. Sub systems considered in VDI 2048 formulations should be as per BHEL requirements.
2. Accuracy of algorithms shall be checked with design test cases provided by BHEL and the absolute accuracy shall be below 0.1% to 0.75% for ideal data, depending on the choice of measurement.
4. Acceptance test shall be carried out using CSV file inputs.
5. The above is gross criterion for Acceptance; however detailed Acceptance Test Protocol shall be worked out during detailed design and as approved by BHEL.

Specs for development of Module II

1. Module II shall be designed based on Artificial Neural Nets/Machine Learning techniques.
2. Data from turbines, low / high pressure heaters, pumps, condensers, mills, fans, economizer, superheater, reheater, furnace and heating sections of boiler shall be considered. The exact data list shall be selected during the course of development and BHEL shall finalize the list.
3. Outlier detection using any one or a combination of algorithms listed below shall be employed.
(a) Support Vector machines
(b) Self Organizing Maps

(c) Any other clustering algorithm suitable for the data reconciliation problem envisaged above
4. Both supervised and unsupervised learning techniques shall be considered as per BHEL's recommendations.
5. Vendor should submit a tentative detailed technical proposal on the use of above algorithms as applicable to thermal power plants.
6. List of parameters considered for validation / reconciliation shall consist of both measured and non-measured variables along with redundancies.
7. Multiple neural nets/Learning algorithms should run simultaneously and each net shall have different set of configured inputs.
8. Provision should be there to configure network type / topology for different subsystems.
9. Training of nets shall be carried out using both on-line and off-line data.

Acceptance Criterion for Module II

1. For each network configured for a process boundary, the network predicted value shall be within a tolerance limits provided by BHEL.
2. Simultaneous functioning of different networks shall be checked by configuring different networks with design inputs and trained with off-line data and by choosing a different design case. The different networks shall predict the outputs within close tolerance which shall be fixed during detail design phase.
3. Acceptance test shall be carried out using CSV file inputs.
4. For the purpose of testing on-line training facility, a skeletal application shall be developed which writes data to a pipe and module shall read data for training.
6. The above gross Acceptance criterion shall be detailed during design and shall be approved by BHEL.

Common to Module I and II

1. Display screens of Process descriptions showing measured and calculated data.
2. Configuration of field Sensor List to module I module II separately.
3. Input Parameter list shown using a Tree View separately for each module.
4. Add / delete a parameter to the configuration list.
5. Configure Sensor/parameter Properties.
6. Add / delete / update sensor/parameter properties
7. Configuration should be stored in a file / database.
8. Properties of each signal/parameter should be shown upon user selection in Tree View.
9. Parameter trend plots using Y1, Y2,..Yn vs. X shall be provided for each module.
10. Parameter selection for trend plot can be chosen with drag and drop from tree view.
11. Plane graph showing classification of patterns in case of Neural nets/Machine learning.
12. Multiple trend graphs can be opened simultaneously.
13. Trend graph should highlight raw, validated / reconciled and invalid portions of signals.
14. Presentation of signal statistics as applicable to VDI 2048 and as finalized by BHEL; signal statistics shall be presented in tabular form / graphic format.
15. Integration of Module I and Module II as per BHEL requirements.
16. Any mutually agreed design alterations shall be incorporated during the development phase.
17. BHEL reserves the right to finalize the details of the scope of module, module II and common portions.
18. Entire thermal Power plant process shall be modeled to predict the ideal / design values of all parameters at inlet and outlet conditions of equipment, for a given load. Design data at three loads shall be provided by BHEL. Vendor should submit a tentative detailed technical proposal containing methodology for prediction of parameters including turbine and boiler sections with their respective heaters.

19. Language of implementation shall be VC++ / VC# / Java / Qt; shall be decided during detail design.
20. Coding should be as per BHEL guidelines.
21. OS is MS Windows XP Prof. / Windows 7.
22. Data store shall be File / MS Access/Oracle/MS SQL.
23. Security in terms of authorization to run and stop modules independently. Only one instance of each module should be permitted to run.

Deliverables

1. Architecture and Design documentation showing class diagrams, Sequence/Collaborative Diagrams, Flow Charts, data structure details etc. separately for Module I and Module II.
2. Fully commented Total source code for both Module I and Module II.
3. Test Protocols / reports for Module I and II separately.
4. Special tools and their usage, if any used.
5. Full Executable Modules.
6. Executable modules shall also be supplied as installable versions using self extracting feature.
7. Full on-site training on usage and maintenance for Module I and II of Part A and Part B separately.

General

1. Vendor should submit technical and commercial quotes separately for Module I and Module II.
2. Technical Offers for Module I and Module II should contain detailed design methodologies of development.
3. The vendor must have successfully executed S/W development projects for any Central Government Establishments / PSUs. Proof to be provided without which the offer shall not be entertained.
4. Vendor should have previous expertise in thermal power plant process modeling and also expertise in developing Artificial Neural Network based applications. The vendor should provide proof of both these expertise.
5. Vendor must be willing to execute NDA at the time of Ordering.
6. Vendor must provide on-site development / testing support; time period of support shall be total duration of development.
7. Warranty / Guarantee should be provided for not less than one year from the date of delivery.
8. Bug fixes during the warranty period shall be carried out free of cost.
9. Vendor shall be penalized / black listed in the event of abandoning the development in the middle of the project.
10. Vendor should submit tentative Quality Test plan for Module I and II.
11. The developed modules will be solely the property of BHEL. BHEL reserves the exclusive IPR rights. Vendor can not publish any information connected with this development without written permission of BHEL.
12. Payments shall be Module wise based on satisfactory clearance of functionally.

For any Technical Clarifications please contact –

Shri RVS Krishna Dutt, AGM(MDF) / Mr Manish Agrawal, Sr Engineer (MDF)

Email ID: krishnadutt@bhelrnd.co.in / manishagrawal@bhelrnd.co.in