**ABSTRACT:** FSSS is a collective digital logic system for the safety and protection of furnace during starting, shut down, low load and emergency conditions. At present most of the plants use analog and relay based system which has more hardware components causing frequent maintenance due to failure of components. Further causing delay for fault deduction and rectification during failure of FSSS. A system is proposed for burner management of boiler using Microcontroller along with interface components incorporating all safe and protection system embedded in a single chip. Further data logging, monitoring, protection and annunciation system also programmed so as to function as independent system. Lab scale simulation was carried out and advantages are highlighted.

**I INTRODUCTION**

FSSS starts with safe operating condition and shutdown if unsafe interlock condition exists. Also hold back start-up when dangerous conditions exist.

FSSS consists of the functions namely a) Furnace Purge Supervision b) Secondary air damper control c) Ignitor control supervision d) Heavy Oil Control and Supervision e) Mill and Feed control and Supervision f) Flame scanners intelligence and checking and g) Overall boiler flame failure protection.

Due to advancement of technology, existing system should be renovated. In this regard several researchers contributed to develop FSSS using latest technology.

Peng Wang et al [1] developed an evaluation technique for FSSS. Furnace safeguard supervisory system (FSSS) plays an important role in protecting the boiler of thermal power plant from danger. In order to evaluate the performance of FSSS itself, functional safety theories are applied in this paper to achieve hazard and risk analysis, target safety integrity level (SIL) determination and functional safety evaluation. The most important safety instrumented function (SIF) of FSSS-master fuel trip (MFT) is considered, and the probability of failure on demand (PFD) is calculated based on the method of fault tree analysis (FTA).

Pingli Wu [2] designed Furnace Safeguard Supervisory System (FSSS) of gas-fired boiler, which includes the logic design of sweep control for ignition before and after shutdown, the logic design of sequence control for boiler ignition and blast-furnace gas, the logic design of Master Furse Trip (MFT) and Flame Detection.

R.Paul et al [3] dealt with the possibilities of renovation and modernization (R&M) options in an existing 210 MW pulverized coal fired thermal power plant. Three different options along with its cost implications have been discussed based on the performance and cost of generation. The performance of the unit for all the three options is examined under the consideration of increasing the availability of the unit with continuous capabilities to generate power maintaining normal operating parameters over an extended life of at least 15 years. The results reveal that with the R&M approach the unit availability can be increased to more than 85%, with a capacity enhancement of 215 MW.
Nirvesh Mehta et al [4] concerned with calculating boiler efficiency as one of the most important types of performance measurement in any steam power plant. Thermal power plant converts the chemical energy of the coal into electricity. The heat rate of a conventional coal fired power plant is a measure of how efficiently it converts the chemical energy contained in the fuel into electrical energy. Heat rate is expressed as kcal/kwh. The aim of monitoring boiler performance is to control the heat rate of plant. This paper deals with determination of operating efficiency of Boiler and calculates major losses for 210 MW units in India. 

Zheng et al [5] discussed on 1000MW thermal power the first one million kilowatts unit project, in central China. It is also China's first with "big pressure on the small" approach approved one million kilowatts unit project. This article describes the FSSS boiler protection system debugging, application of 2*1000MW units, from system debugging, maintenance, use, etc.

Y. L. Duan et al [6] dealt a Furnace safety supervisory system (FSSS) of a modern boiler monitoring system to ensure the safety of the boiler combustion system. The FSSS system of the 130t/h full gas-fired boiler has some security flaw. The FSSS system of the boiler system is transformed. The system's software capability was improved, the system hardware was upgraded and the system operability is significantly improved. A 72-hour test run was carried out. The experiment results show that the FSSS system meet the design requirement.

Cai Yejing e al [7] Aimed at the problems of coal-fired utility boiler, such as flame fluttering, isolated noise, and lacking adequate contrast in flame image. To extract characteristics of flame image for combustion mode identify, the mean of multi-image, median filter, subsection gray linear transformation, binarization, isolated spots elimination and filling in blanks were operated. The result shows that the flame segmentation from background is effective.

Andrew Rieland [8] discussed the design and implementation challenges of applying Burner Management System design practices to a modern cement plant. As a required safety element of a combustion system per code, a BMS design reflects not only many code requirements, but the design is also heavily influenced by the process design, equipment design and desired operating methods[9-15]. The two primary safety functions provided by a BMS are to ensure a safe atmosphere to begin the combustion process and also to provide flame supervision while combustion is ongoing. Equally important is how the information processed by the BMS is presented to the process operator enabling efficient decision making related to the combustion system.

In order to incorporate latest technology developer in electronic field, an advanced FSSS is developed incorporation all safety and protection. In addition data logging, monitoring[16-18], protection and annunciation system also programmed so as to function as independent system.

This paper is organized as follows: Section 1 presents the introduction and the prose of the previous research[19-24], Section 2 describes existing Section 3 describes the proposed method of FSSS. Section 4 describes results & conclusion is presented at the end.

II CONVENTIONAL FSSS

The FSSS consists of the following components namely, a) Logic cabinet, b) Secondary air damper control, c) Mill panel, d) Field equipment and e) Interface equipments. The system logics are grouped as a) Unit logic b) Elevation logic and c) Corner logic for inter dependant operations[25-29]. The logic cabinet, secondary air damper Control and Field Equipment details are shown in fig 1-3.
The relay logic circuit for furnace purge, start, stop and monitor igniters’, oil guns, coal feeders etc fabricated and erected in the corresponding sites[30-36]. Flame scanner, flame monitoring and overall furnace flame failure protection are also equipped in the console and interfaced with remote monitoring system.

Furnace Purge logic for complete removal of unburnt fuel from entire furnace is shown in Fig 4. When all logic conditions are satisfied a command to purge will be applied and furnace purging will be initiated[37-42]. ON/OFF timer will take care of the timer logic for a purge time cycle of 9 min.

The Protection logic, Flame failure logic, Start/Stop logic , Elevation Monitoring, Secondary/Primary air damper control logic, Primary/Secondary air Fan, Scanner, Wind box logic are also incorporated using relay and switches[43-45].

III ADVANCED FSSS

Hardware System

The modular based hardware design consists of the following: 1) Signal conditioning and input module,
2) FSSS Microcontroller interface module, 3) Start-up/shutdown module, 4) Output module, 5) Display module, 6) Alarm module and 7) Protection module. The interface diagram is shown in fig.5.

Software System

Software consists of the following routines: Diagnostic, Initialization, Declaration of the inputs, Data collection, Assignment of the inputs to the variables, Computation of signals, Assignment of the output variables, Assignments of results to the respective modules, Manipulation of data for display on the monitor, recorder and printer, Data logging, Assignment of data for alarm and protection modules and data communication interface.

System Program

The diagnostic routine will check whether the system is ready for operation. After initializing, the input system routine will receive the input signal from the input module and process them. The control data collection will receive the data as per the FSSS logics send output to the respective modules. The same signal is made available for information system for the monitor, printer and data logging purposes. Protection routine cyclically monitors the alarm value and when it exceeds the limit a signal will be generated for taking the protective action. Data communication routine will put all the signals on the bus with the computer. The programming language C++ is used for all the above software routines and converted into assembly language to embed in the system memory.

IV SIMULATION RESULTS

The simulation of FSSS interface system was done using lab scale fabricated experimental setup. The proposed system was tested for all conditions like start up, shut-down, load raise status etc, and performed efficiently.

V CONCLUSIONS

The performance of the proposed FSSS processor is more efficient and faster than the conventional digital controller. Response and processing time was faster. This resulted around 50% improvement when compared with conventional methods. Also FSSS operating system responded well for all safe and unsafe condition. The approach can also be used for any other process applications.

REFERENCES


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