TECHNICAL PROGRESS REPORT #5

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Mercury Specie and Multi-Pollutant Control

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Disclaimer

Acknowledgment

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Abstract

This report is the fifth quarterly Technical Progress Report submitted by Pegasus Technologies, Inc., under Award Identification Number, DE-FC26-06NT42389 for the effort entitled "Mercury Specie and Multi-Pollutant Control.

This report is the fifth of the required reports listed in Attachment B Federal Assistance Reporting Checklist, part of the Cooperative Agreement. This report covers the award period from April 1, 2007 to June 30, 2007 of the efforts within the first budget period which include among other items the installation of advanced sensors and optimization systems, capture of as found baseline data, and beginning and completion of parametric testing during that period.

Table of Contents

1 Introduction

This project was awarded to demonstrate the ability to affect and optimize mercury speciation and multi-pollutant control using non-intrusive advanced sensor and optimization technologies. The intent is to demonstrate plant wide optimization systems on a large coal fired steam electric power plant in order to minimize emissions specifically including mercury while maximizing the efficiency, and maintaining saleable byproducts of the plant as an electricity producer. Advanced solutions utilizing state of the art sensors and neural network based optimization and control technologies will be used to maximize the portion of the mercury vapor in the boiler flue gas which is oxidized or captured in particle bonds resulting in lower uncontrolled releases of mercury.

Budget period 1 is defined in the scope as the design period. The formal scope deliverables for budget period 1 include the installation of all sensors, design of software system, and establishment of the as-found baseline, conducting parametric testing and producing operating and test metrics for pre-project and post-project data comparison, as well as the required project management steps including the budget period 1 review meeting.

This report covers the fifth quarter of the project. This period was focused on initial activities related to installation of key sensors and the communications to them. Also during this past quarter many of the initial engineering on the Optimizers including functional specifications, MV lists, I/O lists were begun or submitted to the site for review.

Pegasus/NeuCo is shouldering 61% of the total project cost; while DOE is providing the remaining 39%. The DOE requires repayment of its investment. This repayment will result from commercial sales of the products developed under the project. NRG Texas (formerly Texas Genco) is contributing the host site, human resources, and engineering support to ensure the project's success.

2 Executive Summary

Pegasus/NeuCo has worked on the project during this fifth reporting period and as such is proceeding along the schedule path however at a slower pace than originally proposed. This is principally due to two issues. One is a deviation from original plan due to a business transaction and resulting typical transition of personnel which can occur in such transactions. The second and the principal single effect on critical path is that an outage was required for final installation of the Zolo equipment. This is not in small part due to the late start during the primary outage which was already in process prior to the CA authorization. The Zolo equipment is now physically installed and is beginning the process of being calibrated. This delay for the required unit outage has resulted in a net 5 month delay of BP1, for which we have been granted a "no cost extension". The project scope of work entails the installation and demonstration of sensors and optimization software in 6 technology packages as well as the required Project Management tasks. Many of the sensors and optimizer technology that will be installed are utilized across the modules; therefore, they have been included under the module in which they are most used. The technology packages as defined in the CA for this project include:

2.1 Intelligent Fuel Management System (FMS)

The FMS is composed of the Combustion Optimization System, the Ready Engineering Coal Fusion System, and SABIA's elemental analyzer.

Pegasus/NeuCo project management has worked with and directed the sub-vendors of this task. The Sabia elemental analyzer has now finished calibration and is producing reasonable analyses. Many of the calibration steps included work performed by the Limestone site personnel including the gathering of controlled coal samples.

Pegasus/NeuCo has completed the task associated with Sabia. This also begins the initial period for baseline accumulation of data.

Ready Engineering has completed the installation of equipment at site. Limestone has finished programming the HMI interface for the Ready equipment. Final configuration is complete. The system performance has had preliminary testing and final testing is in part waiting on unit 1 to complete a different project test unrelated to this effort but using common coal delivery equipment.

2.2 Mercury Specie Control System:

The Mercury Specie Control System includes the boiler area optimization, sensors from ZOLO, PS Analytical, and Triple 5. Mercury emissions will be measured through Continuous Emission Monitors (CEMs) by PS Analytical.

Zolo port rodder option was installed during the planned outage in March 2007. This wait for a unit outage has resulted in a net 5 month delay of BP1, for which we have been granted a "no cost extension". Eight laser paths were established, and Zolo results are

being sent from their data file to the DCS. One final software upgrade is required from Zolo prior to the acceptance testing of the Zolo portion.

The Triple 5 coal flow sensors are installed and have shown flow related signals.

PSA mercury analyzers are now physically installed and being modified to overcome problems with the span measurement. This issue is expected to be resolved in the next quarter.

2.3 Advanced Electrostatic Precipitator (ESP) Optimization

Advanced Electrostatic Precipitator (ESP) Optimization System: The ESP Optimization System is composed of a Carbon-In-Ash (CIA) virtual online analyzer, a CIA sensor from ABB, and ESP Optimization software.

The ABB Carbon-In-Ash (CIA) zero (no load) calibration was done and several rounds of samples were sent for analysis. Calibration is now complete with the exception of two ash volume probes (stretch goal). Erosion of dust probes is being addressed.

Pegasus/NeuCo has worked with Solvera (stock equipment) to order, manufacture, and install an MIU (communications device) for the exchange of data in and out of the TR set voltage controllers of the ESP. This will enhance baseline and testing data as needed for the ESP. Data collection tags are currently being configured. Output data back to the AVC TR sets is being worked on by our personnel.

2.4 Advanced Intelligent Soot Blowing (ISB) System:

Advanced Intelligent Soot Blowing (ISB) System: The ISB system is composed of Neuco Intelligent Sootblowing software. Note that this module was previously demonstrated, and does not constitute new demonstration technology although certain advances are likely.

The Limestone sootblowing I/O list and interface has been completed and the programming interface discussed with site. Input data is now being collected from the sootblower OPC server. A sootblower application template has been added, and is being customized for this installation.

2.5 Advanced Flue Gas Desulfurization (FGD) Optimization System:

Advanced Flue Gas Desulfurization Optimization System: The FGD Optimization System is composed of Pegasus' FGD Optimization software.

The Functional Specification for the FGD was updated to reflect DBA price increases. Limestone has elected to continue using DBA instead of the proposed replacement chemical.

2.6 Intelligent Optimization:

Intelligent Plant (Unit Optimization): The Pegasus i-Plant Optimization System will arbitrate among the solutions for the above systems.

Architecture for the overall systems design including communications architecture, DCS point access, and all advanced sensor inputs was designed and implementation continued to be worked on during this period. A list of 922 points was developed for collection of baseline data. All points are showing the same status as the DCS points.

2.7 Project management required activities

Project management required activities were completed during the period.

3 Discussion

3.1 Discussion Overview

During this fifth reporting period from April 1, 2007 through June 30, 2007, the major effort has been the installation and communications to the advanced sensors. Reasonable progress to that effort has been achieved. Below is a discussion organized by package that corresponds to those listed in the CA. Figure 1 shows the architecture of the packages as mapped to over the site schematic.

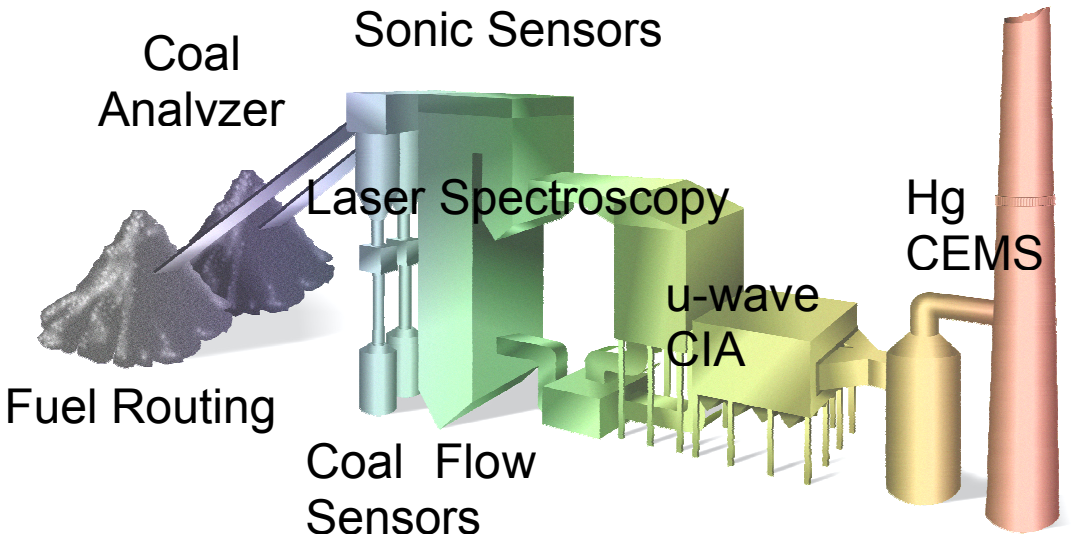

Figure 1 Advanced Sensors being added

3.2 Discussion by Package

The Application engineers continued working with site personnel to exchange specific detailed information about each area of the plant for data capture.

3.2.1 Intelligent Fuel Management System (FMS):

The FMS system consists primarily of the area from the fuel pile to the entrance to the mills. The FMS primary subvendors are Sabia Inc. and Ready Engineering. Sabia has been validated and accepted, no activities apart from maintenance are further required in BP1.

a. Goals for the past quarter were:
    i. Install Ready Engineering CoalFusion.
    ii. Install rotary plough position indicators
    iii. Test Ready Engineering Coal Fusion design

b. Accomplishments for the past quarter were:
    i. Ready Engineering Coal Fusion design is complete and installed.
    ii. Re.- Ready; Rotary plough position indicators are now installed.
    iii. Re.- Ready; Limestone are almost complete with dry run testing and need to schedule final tests for Coal Fusion.

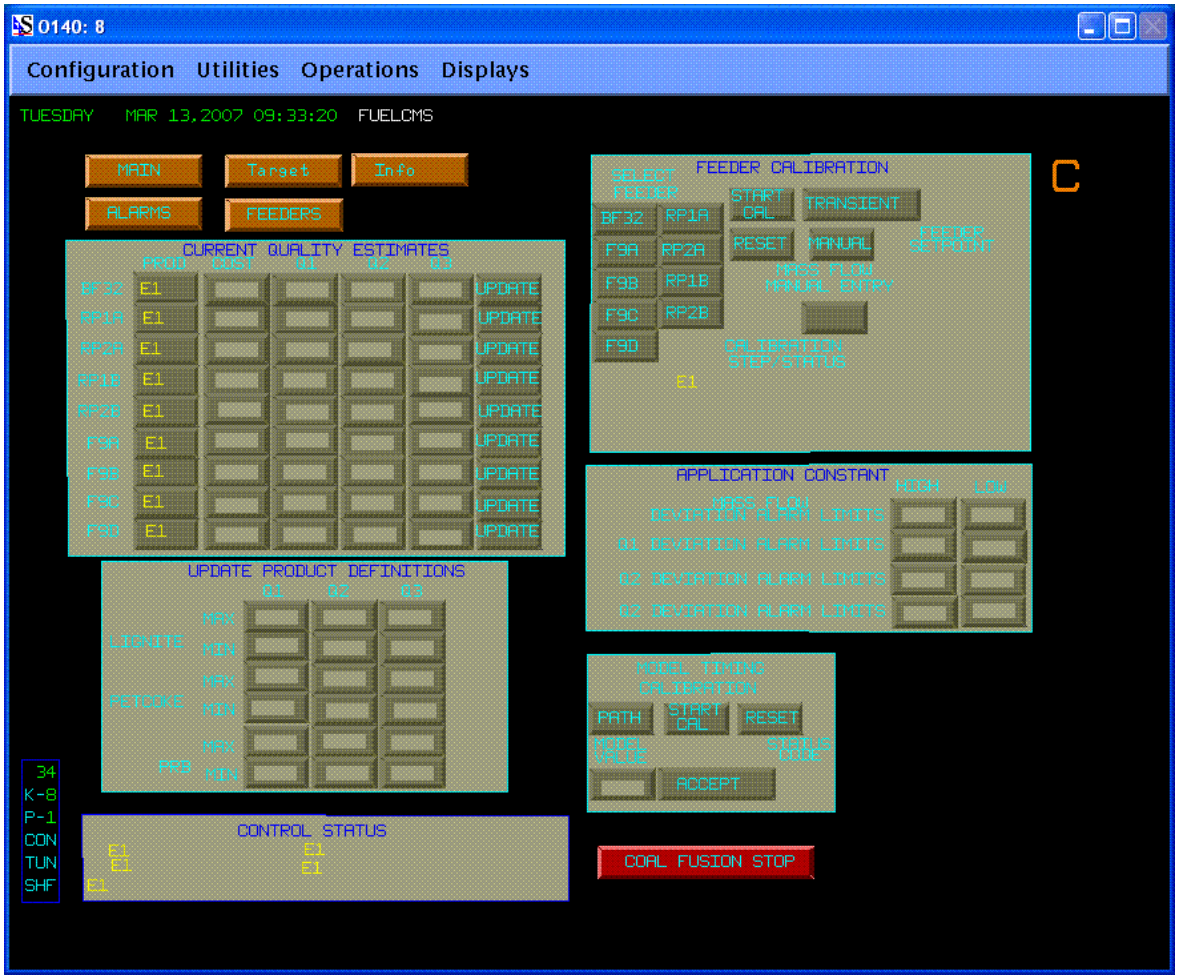

Figure 2 Sabia HMI Screen Example

3.2.2 Mercury Specie Control System:

The Mercury Specie Control System includes Pegasus' Virtual Online Analyzers (VOAs); sensors from ZOLO, PS Analytical, and Triple 5; Mercury emissions will be measured through Continuous Emission Monitors (CEMs) by PS Analytical

a. Goals for the past quarter were:
    i. Establish communications to PSA computers.
    ii. Operate PSA Hg CEMS equipment and begin site training and calibration.
    iii. Complete the laser spectroscopy installation and begin verification.

b. Accomplishments for the past quarter were:
    i. Communications are now established to both PSA analyzers.
    ii. Hg CEMS are physically installed and operating. They are still having problems with span calibrations. Reliability and run in time are very important also.
    iii. The Laser spectroscopy equipment is fully on site and all base elements have been installed and operable. The unit had slag on the walls which necessitated the ordering and the installation of "port rodders" on both sides of the unit. These are now installed and operational. Laser signals were successfully sent through all ports. This verification process will continue during the next quarter and remains the critical path.
    iv. The CombustionOpt Functional specification was reviewed by NeuCo.

3.2.3 Advanced Electrostatic Precipitator (ESP)

The Advanced Electrostatic Precipitator (ESP) Optimization System is composed of a Carbon-In-Ash (CIA) virtual online analyzer, a CIA sensor from ABB, and Pegasus's ESP Optimization software.

a. Goals for the past quarter were:
    i. Calibrate the ABB CIA monitors
    ii. Configure the OPC server to gather CIA data online.
b. Accomplishments for the past quarter were:

    i. The ABB Carbon-In-Ash (CIA) zero (no load) calibration was done and several rounds of samples were sent for analysis. Calibration is finished, except that ash loading still needs to be verified.
    ii. The OPC server configuration is continuing, and data gathering should start early next quarter.

3.2.4 Advanced Intelligent Soot Blowing (ISB)

The Advanced Intelligent Soot Blowing (ISB) System is composed of Pegasus' Intelligent Sootblowing software. Note that this module was previously demonstrated, and does not constitute demonstration technology.

a. Goals for the past quarter were:
    i. Prepare the Functional Specification for the ISB.
    ii. Prepare a test plan for the ISB.
    iii. Install pre-configured template for soot blower system.
b. Accomplishments for the past quarter were:
    i. The functional specification for the ISB was not completed due to limitation of personnel while working other facets of the project.
    ii. The test plan for the ISB was not completed due to limitation of personnel while working other facets of the project.
    iii. The template is now installed.

3.2.5 Advanced Flue Gas Desulfurization Optimization System (FGD

The Advanced Flue Gas Desulfurization Optimization System (FGD) Optimization System is composed of Pegasus' FGD Optimization software.

a. Goals for the past quarter were:
    i. Issue the functional specification.
    ii. Test the suggested DCS changes.
    iii. Implement the display changes
b. Accomplishments for the past quarter were:
    i. The functional specification was issued.
    ii. The suggested DCS changes were completed and tested.
    iii. The display changes have been implemented.

3.2.6 Intelligent Optimization

The Pegasus Optimization Systems will arbitrate among the solutions for the above systems.

a. Goals for the past quarter were:
    i. Establish a path forward for the simulator.
    ii. Draft the functional specifications for the VOAs
    iii. Configure the PERFIndex and load to site.
b. Accomplishments for the past quarter were:
    i. A simulator path forward was established.
    ii. The functional specification for the VOAs was not completed due to personnel assignments on other areas.
    iii. The Configuration of the PERFIndex is in process.

4 Cost Status

This period report EVA is the "no cost extension" reforecast adjustment. Period from March 31 to June 30, 2007

A proportion of the initial spending was done at risk to Pegasus under the terms of the pre-award agreement. This initial funding was used in large part to procure the initial subvendor contracts in order to make best as possible use of the unit outage at Limestone. Much of the critical work was accomplished and as of this date no schedule adjustment from originally proposed dates are noted. Some future adjustment to schedule may need to be taken which would accommodate delays in the CA approval process; however none are anticipated as this report. Pegasus remains working to achieve the draft schedule submitted in 2005 prior to the issuance and final approvals of the CA

Total approved budget for Phase I	$9,156,712
DOE Share of Total Approved Budget	$3,577,451
Pegasus/NeuCo Share of Budget	$5,579,261

Table 1: Project Spending per form 270 June 2007

	This Period	Project to Date
Expenses	$401,236.60	$3,056,595.29
G&A Expense	$244,799.01	1,788,886.41
Total Quarterly Expense	$646,035.62	4,845,481.71
Billable Percentage	0.390692	0.390692
Quarterly DOE Billable Amount	$ 72,150.32	$1,893,090.94
Quarterly Pegasus Non-Bill Amount	$ 112,522.82	$2,952,390.77
DOE Billable	$230,484.18	$1,893,090.94
DOE Billed	$238,513.99	$1,831,111.31
DOE Unbilled	($8,029.81)	$61,979.61

5 Schedule Status

The progress to schedule is behind schedule. The highest risk items of the Zolo Laser spectroscopy and the PSA Mercury CEMS remain the largest factors in the delay. Zolo has suffered from a software problem that has held up all of their installations market wide. The newest estimate is for them to on site the week of the July 23rd for final installation and testing. This remains behind schedule. The next highest risk item is the Mercury CEMS. The filters and dilution ratio diaphragm have been changed but the dilution ratio remains lower than anticipated and thus inhibiting solid span calibration. The third item was the adjustment of the simulator and model interface for the training simulator with the VOAs as well as plant wide energy balance and deviation prediction. A path forward has been agreed to by site, and reviewed by the COR and technical advisor, but waiting on final e-mail acknowledgement of same. If there are no delays this should free up many tasks to allow engineers to be tasked with installation of the i-plant related software and unit's design and configuration of same.

6 Reportable changes or problems for the period

No CA or SOPO changes to report during this period. However there was the aforementioned delay with subvendor installation time and a report of change to the Simulation vendor and associated architecture was sent as notification to the DOE COR. A request for Novation was submitted in spring and a meeting to discuss with DOE is anticipated in July.

7 Absence or changes of key personnel

No changes to report during this period.

8 Product Completed/Produced, Technology Transferred, Presentations, Patents

9 Conclusion

The project has moved forward on accomplishing the primary area of focus which is the installation of advanced sensors. All of these devices have had their base equipment installed and are in various stages of configuration, calibration, or verification. There have been some disruptions and delays to schedule as discussed. We do not consider any of the delays related to technical concept barriers.

9.1 Intelligent Fuel Management System (FMS)

Pegasus/NeuCo and site are continuing technical work with Ready Engineering Coal Fusion System. The SABIA elemental analyzer for this task is completed and in the warranty period.

9.2 Mercury Specie Control System:

All equipment in this section has been physically located and is in various stages of completion for tuning and calibrations. The Zolo Laser Spectroscopy Analyzer sensors needed an opportunity outage for installation while the Triple 5 coal flow sensors are being completed easily and ahead of planned effort. The Mercury CEMS have had calibration problems, which are being resolved, and can now continue forward but remain something to monitor for risk. This is one of the most significant measurements in the project and as such is being monitored by all involved.

9.3 Advanced Electrostatic Precipitator (ESP) Optimization

Pegasus/NeuCo has installed equipment to interface serially to the TR sets of the ESP. This data exchange will enable the most complete set of data to be captured. This equipment has already been connected at site. The data and I/O matrix of the functional specification for the ESP was completed, and approved with site. OPC communications have been established and tag configuration is underway.

9.4 System Advanced Intelligent Soot Blowing (ISB) System:

Pegasus/NeuCo and Limestone's systems engineers have completed the method for interface to the existing sootblowing system and have established the required I/O list for this section. A template for this application was imported into Process Link.

9.5 Advanced Flue Gas Desulfurization (FGD) Optimization System:

The functional specification for the FGD has been reviewed.

9.6 Intelligent Optimization:

Simulation discussions are on-going with site as reported in the April 4 meeting. A path forward has now been agreed upon.

9.7 Project management

Project management required activities were completed during the period.

10 References

None to state for this report

11 List of Acronyms and Abbreviations

(Consolidated list as may be used in this or future reference reports)

API	Application Programming Interface
BTU	British Thermal Unit
CCPI	Clean Coal Power Initiative
CEMS	Continuous Emissions Monitoring System
CO	Carbon Monoxide
CO2	Carbon Dioxide
DCS	Distributed Control System
DOE	Department of Energy
FEGT	Furnace Exit Gas Temperature
ESP	Electro Static Precipitator
FD	Forced Draft
FGD	Flue Gas Draft
FT^3	Cubic Feet
GUI	Graphical User Interface
HMI	Human Machine Interface
HR	Heat Rate
H_2O	Water
ID	Induced Draft
ISB	Intelligent Sootblowing
LAN	Local Area Network
LOI	Loss on Ignition
Mol Wt	Molecular Weight
mmBTU	Millions of BTUs
mm	Million
MW	Megawatt
mWh	Megawatt hour
M/year	Million per year
N_2	Nitrogen

NH_3	Ammonia
NOx	Nitrogen Oxides
O_2	Oxygen
OEM	Original Equipment Manufacturer
OFA	Over Fire Air
OPC	OLE for Process Control
PC	Personal Computer
PLC	Programmable Logic Controller
ppm	parts-per-million
PRB	Powder River Basin
PTC	Power Test Code
RH	Re heater
S	Sulfur
SA	Secondary Air
SH	Super Heater
SO2	Sulfur Dioxide
SO3	Sulfur Trioxide
TC	Thermocouple
VPN	Virtual Private Network
V&V	Verification and Validation