PRODUCT SPECIFICATION

TITLE	DATE	REV
Product Requirements	27 June 2018	2

Project UI-Steam Plant
Product Requirements

Rolling Timber II

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Document History

Rev Number	Date	Modified By	Reason
1	25 June 2018	Zak, Mia, Mike	The first draft
2	27 June 2018	Mia	The second revision

Table of Contents

1 Objective

The objective of our capstone project as Rolling Timber II is an extension of previous work with the intent of generating an operating lab prototype that can enable full-scale implementation in the UI Steam Plant.

Rolling Timber II are required to measure and record the primary fuel variables for the wood fired boiler at the UI Energy Plant. The measurements can be used as inputs to automate the wood fired boiler combustion controls. Mass fuel flow of the wood chips, moisture of the wood chips, mass air flow, air temperature and air moisture flowing into the boiler are all necessary to optimize combustion.

Team Rolling Timber I (the previous team) was able to design and build a prototype sensor for mass fuel flow and fuel moisture content. These sensors will need to be refined and then a measurement and verification process can either prove or deny the design concept. Additionally, the measurement of mass air flow, temperature and moisture content will need to be developed.

2 Scope

The scope of this project is to create a monitoring system to increase the steam plant efficiency. Our goal is to essentially take the steam plant from a carbureted system to a more efficient and controllable EFI system. By monitoring the moisture content and mass flow rate of wood chips less wood can be used in a more effective manner. If time permits we intend to also monitor the mass flow rate of air being forced into the fire system.

3 References

3.1 Cited Documents

- Wiki page of the previous team (Rolling Timber II)
  http://mindworks.shoutwiki.com/wiki/UI_Steam_Plant_Combustion_Input_Measurement_Systems
- Final portfolio from the previous team (Rolling Timber II)
  ms-appx-web://microsoft.microsoftedge/assets/errorpages/dnserror.html?ErrorStatus=0x800C0005#file:///S:/Engineering/SeniorDesign/Rolling%20Timber%20II/Capstone%20l%20(summer%202018)/Other%20documents/Final%20Report%20from%20the%20previous%20team.pdf
- University of Idaho Steam Plant---Generating Steam with Biomass
  https://www.youtube.com/watch?v=ITdN6GwH9_4

3.2 Acronyms

EPO	Engineering Purchase Order
ER	Engineering Release
POC	Proof of Concept

TITLE	DATE	REV
Product Requirements	27 June 2018	2

4 Functional Requirements

4.1 User Interface Requirements

Name of the measured quantity	Unit	Range of expected values in the plant operation
Mass flow rate of woodchips	lbs/hr green tons/hr	> 2.3 - 7 green tons/hr ※"green ton" refers to a ton of woodchips that have not been dried ※1 ton = 2000lbm
Mass flow rate of air	lbs/s	※We don't know yet. We need to measure that through 2 large ducts
Moisture content of woodchips	lbs/hr, %	> 3 - 60 % by mass

※It is fine to use modified unit such as lbs/min or lbs/s, however, lbs/hr is a unit which is usually used in the plant.

※Please keep in mind to use green tons/hr for any official documentation since it is an industrial standard.

- Scale factor for prototype: There is no scale factor.
  (1:10 might be preferred since it is easy to calculate)
- Source of woodchips: Cedar, Pine, and Fir (These are available in this area)
- Duration of testing prototype: During week 6 (July 9-July 20) <u>(Expected)</u>

5 Mechanical Requirements

5.1 Strength Requirements

No requirements for strength. However, our client recommended us to use mild steel for mechanical components for our mass flow sensor of woodchips.

5.2 Spatial Requirements

Implementation of devices (our design) should be require little to no modification to the existing system in the plant.

- The available space within the throat is 9” wide × 84” long × 26” long. (for mass flow sensor of woodchips)
- Round duct – 24” diameter (for mass flow sensor of air)
- Rectangular duct – approximately the same cross-sectional area as the round duct (for mass flow sensor of air)

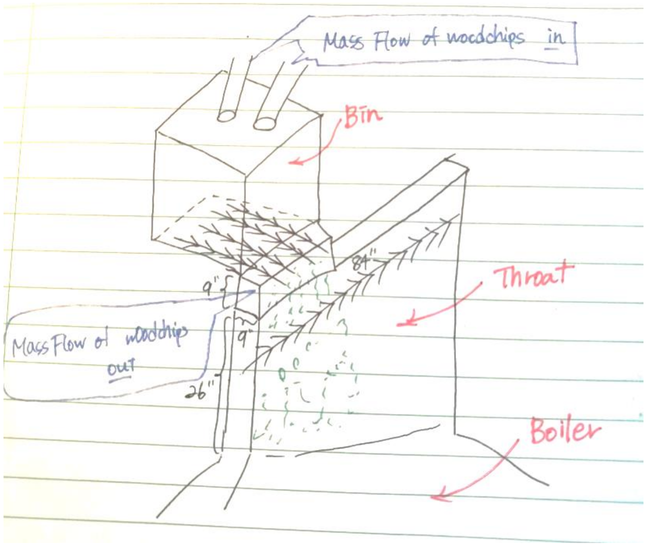
5.3 Weight/Mass Requirements

No requirements for weight or mass

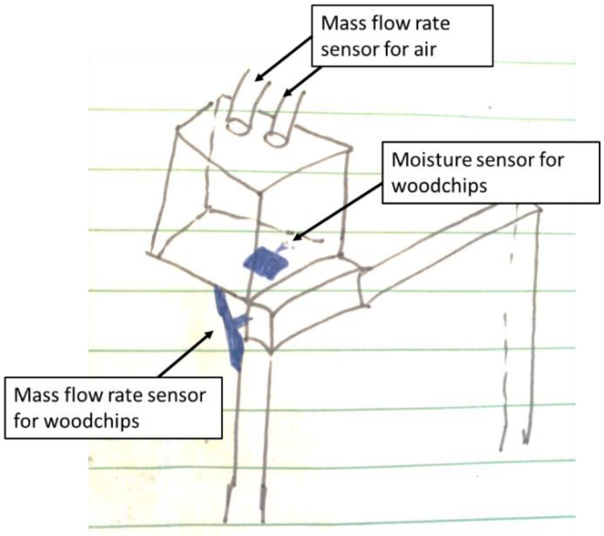
TITLE	DATE	REV
Product Requirements	27 June 2018	2

5.4 Mounting / Interface Requirements

This is the visualization for the plant structure. Woodchips are filled through the two tubes on the top and they are stored inside the bin for a while. Regularly, some of the woodchips are smashed into smaller pieces by augers on the bottom of the bin and are sent to the throat. Once they travel thought the throat, they are dropped into the boiler and burned.



The image below is describing the possible place to install our devices/designs for mass flow sensor of air, mass flow sensor of woodchips, and moisture sensor of woodchips. These locations are carefully examined by the previous team with a lot of research and determined. So we (Rolling Timber ll) decided to use their ideas about where to mount our designs.



5.5 Appearance Requirements

There are no appearance requirements as long as our design accomplish the functionality our client needs.

5.6 Durability Requirements

The system should be designed to operate for 5000hrs (6 months) without any scheduled maintenance.

5.7 Reliability Requirements

All components should have 90% reliability.

- Our design should survive in the case of bin fires
- Our design should be functional in the dusty environment of the steam plant

6 Electrical Requirements

6.1 Rolling Timber 1 Circuits

As of June 20, 2018 the Rolling Timber 1 system consists of 2 DC power supplies. Power supply 1 outputs 24V DC which powers the moisture sensor as well as a volt to current converter. Power supply 2 outputs 10V DC (actually 11V DC due to poor PSU quality) to the load cell as well as an Operational Amplifier. This OpAmp serves to amplify the signal from the load cell then this amplified voltage signal is converted into 4-20mA for the display system. The moisture sensor is already set to output in this 4-20mA system and plugs directly into one of the two displays. Currently these displays are unregulated and uncalibrated. They serve as a simple demonstration of feedback from the load sensor and the moisture sensor. The data displayed on these two displays are just for visual demonstration.

Sensor	**Power Input**	**Signal Outut**
Moisture	24V DC	4-20mA
Mass Flow	11V DC	4-20mA

NOTE: This table is the intentions of the previous team, Rolling Timber I. After some testing we found this system to me uncelebrated and inaccurate. As of June 22, 2018 we believe we need a much more sensitive load cell for our mass flow measurements.

6.2 Sensor Requirements

The sensors purchased by Rolling Timber 1 are high quality high precision sensors. We intend to use these sensors in our designs.

The moisture sensor requires 24V DC to power its system. This moisture sensor then gives a 4-20mA signal as well as a temperature signal of unknown scope. We intend to connect these signals directly into a DAQ to calibrate and interpret the data.

The load cells require 5-15V DC to operate. We currently have a cheap power supply giving 11V DC which is acceptable for powering the sensor. This sensor gives a HIGH precision but LOW magnitude signal in a very low mV range. This signal is amplified by a specialized OpAmp which requires 5-18V DC to operate. This amplified signal is then converted into a 4-20mA signal by a purchased board. For our design we intend to remove this 4-20mA conversion and plug the amplified load cell signal into a DAQ for signal processing.

7 Software Requirements

7.1 Functionality

The function of the software should have obtaining the inputs from our sensors and return the outputs in a proper manner. Hence, the options will be either LabVIEW, Simulink with Matlab, or Arduino software depending on microelectronics we use.

7.2 User Interface

Our client said that plant operators cannot really use the following software in the plant: LabVIEW, Simulink, and Arduino software.

The plant operators use:

"Siemens" (https://www.siemens.com/global/en/home/products/automation/industry-software/automation-software.html) OR

"Procidia" (https://www.industry.usa.siemens.com/automation/us/en/process-instrumentation-and-analytics/process-instrumentation/service-and-support/user-manuals/Documents/OGiSERVER-1r1.pdf)

Hence, we can make it work by using either one of the software, LabVIEW, Simulink with Matlab, or Arduino as long as we can convert the program to the industrial software above by the end of the project.

8 Environmental Requirements

8.1 Temperature

Our prototype needs to be operated in the temperature range of 90F to 100F (32.2°C to 38°C) in the plant.

※ On August, the temperature will be + 20~30 F.

※Cold temperature limit during the winter operation will be 50 F.

9 Cost Requirements

It is reasonable to assume that our project should be done by spending $5500 more or less. This number came from the budget from the previous team. Since the previous team purchased all the necessary instruments and we are carrying over those from them, our budget is expected to be less than $ 5500.

As long as our budget plan and proposal to purchase stuffs are reasonable, our client said that the cost might not be a big problem and it is not his first priority. If we can reach to the phase 6 (implementation in the actual plant), we might include the labor cost for the plant workers in our budget.

10 Project Timeline/Schedule Requirements

10.1 Our client's priorities

Task 1. Mass flow rate of woodchips (Must)
Task 2. Moisture content of woodchips (Should)
Task 3. Mass flow rate of air (Wish)

-Must? : Bring Task 1 up to the phase 5 during summer and up to phase 6 in the fall
-Should? : Bring Task 2 up to whatever phase as far as we can go
-wish? : Bring Task 3 up to whatever phase as far as we can go

- <u>Focus on proving the concept of our prototype by testing during summer.</u>
- <u>Then, focus on scaling and how we can apply that to the implementation in the actual plant during Fall.</u>

10.2 Important date to keep in mind

- Complete testing and proving the concept by August 5th.
- Keep in mind plant shut down in the mid of September. Hence, we need to have a solid plan for the implementation by that time.

10.3 Project Timeline for summer 2018

The following are the major Project Milestones:

- Submission of Requirements June. 25, 2018
- The second client meeting June. 26, 2018
- Submission of project schedule July. 7 , 2018
- The third client meeting July. 3, 2018
- Submission of Portfolio, Initial Wikipage, Logbook July. 6, 2018
- Snapshot 1 July. 9, 2018
- The fourth client meeting July.10, 2018
- Submission of design validation plan July.16, 2018
- The fifth client meeting July.17, 2018
- Submission of project value proposition July.23, 2018
- The sixth client meeting July.24, 2018
- Concept design review with client July.30, 2018
- Snapshot 2 Aug. 2, 2018
- Submission of Portfolio, Initial Wikipage, Logbook Aug. 3 , 2018

※Blue arrows are the things done by the previous team, Rolling Timber 1.

Orange and yellow arrows are the things expected to be done by our team.

Project Schedule of Rolling Timber ll