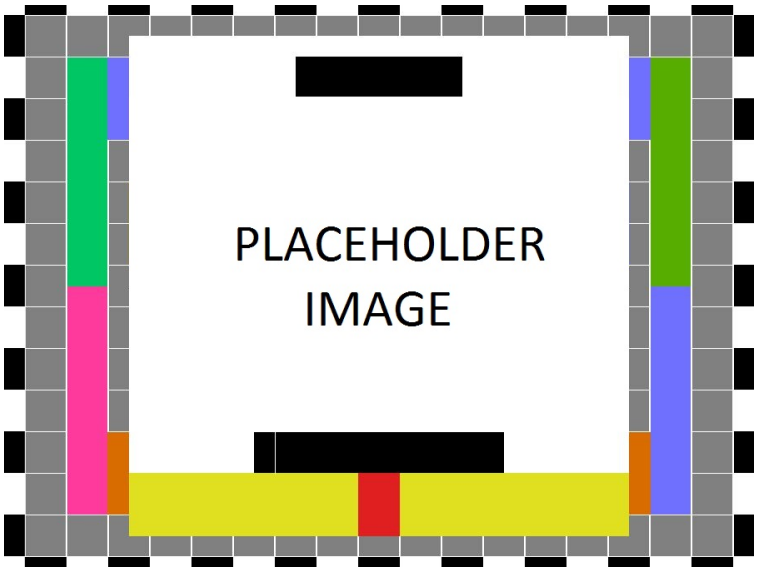
Department of Computer Science & Engineering
The University of Texas at Arlington

System Requirements Specification
CSE 4316: Senior Design I
Spring 2020



Team Friendship
Automated Home Brewing System

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Revision History

Revision	Date	Author(s)	Description
0.1	10.01.2015	GH	document creation
0.2	10.05.2015	AT, GH	complete draft
0.3	10.12.2015	AT, GH	release candidate 1
1.0	10.20.2015	AT, GH, CB	official release
1.1	10.31.2015	AL	added customer change requests

CONTENTS

List of Figures

1 Product Concept

This section provides a high-level statement of your product concept - what it is intended to do and how it is intended to be used. Include in this header paragraph, a brief synopsis of what is described here. For example, this header paragraph might say something like: "This section describes the purpose, use and intended user audience for the X product. X is a system that performs Y. Users of X will be able to Z..."

The "Automated Home Brewing System" is built with the sole purpose of brewing large batch of beer in the home environment. This product provides home brewers with a low-cost electric home brewing system that allow them to have precise control over the brewing process. The brewing process can be automated with th help of micro-controller like Arduino Uno which is then hosted to a local website or an app interface.

1.1 Purpose and Use

This is where you describe in a brief, yet clear and concise, manner what your product should do and how you expect it should be used.

Arduino Uno is a micro-controller that can receive data such as current temperature of the water or mash from the heat sensors located inside the kettles which can be converted to either analog or digital input. The heating coil can be control using the input from the user as per their desired either to increase or to decrease the temperature. The electric pump can also be controlled by the user through micro-controller to regulate the flow of the water in the kettles. The user will be able to communicate with the brewing system through a web interface or app interface.

1.2 Intended Audience

This is where you describe the intended audience(s) of your product. If this product were to be made available publicly or commercially, who would purchase or use it? Is the product designed for a particular customer, or an overall class of customers? Is it intended for general use, or is it a specific component of a more complex system?

The foremost intended audiences for this product would be home brewers or person interested in brewing beer only. Provided that the user manual would be present in the product, any person who wants to brew beer in his local environment can easily use this product. This product is made focusing on how effortless can the brewing process gets simply with the use of micro-controller.

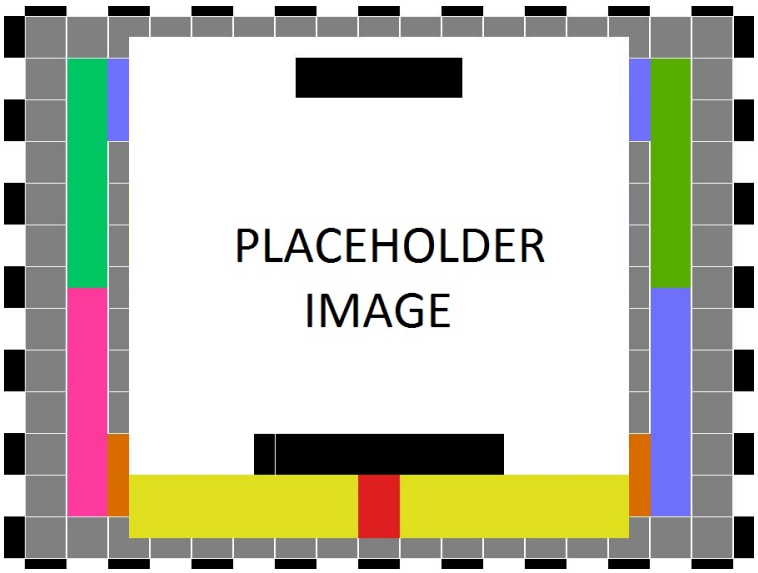

Figure 1: X conceptual drawing

2 Product Description

This section provides the reader with an overview of The Back Burner Brew and will discuss the primary features, functions and interfaces the product will have. The goal of The Back Burner Brew is to automate most of the brewing process to ensure all the liquids heat up and stay at the desired the temperature the brewer wants.

2.1 Features & Functions

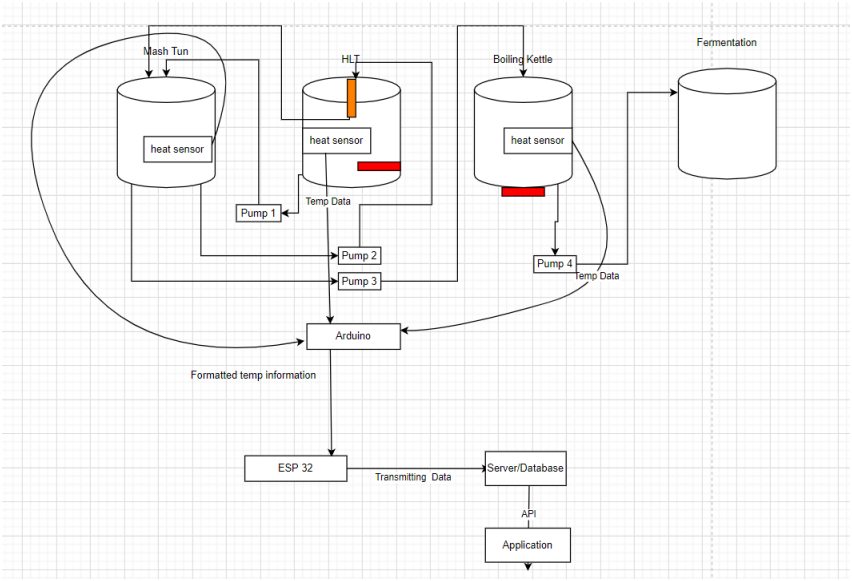

Figure 2: System Overview

The Back Burner Brew will be a utilize four kettles as seen in figure 2 and the liquids will be transferred from each kettle through the use of pumps. The Back Burner Brew will have a user interface, both

through a web application and a touch screen connected to a RaspberryPi. Through these interfaces, the brewer will be able to control the temperature of all the liquids inside of the Hot Liquor Tank (HLT) and the mash tun. Along with controlling the temperature, the user will be able to set when water from the HLT will be sent to the mash tun and when the mash tun will send the liquids through the HLT for heating. The liquds temperatures will be monitored through heat sensors and will be sending that data to the web application. The web application will display the current temperature of the liquids to the user and will have a kill switch in case the heating element does not control the temperature of the liquids as requested by the user.

The product will not control the temperature of the boiling kettle, rather the user will be able to control the power output of the heating element inside of the boiling kettle and will have to monitor the temperature and the amount of water loss through the boiling process. Because there will only be three pumps, the user must move connections manually between the pumps in order to have the liquid inside of the boiling kettle be transferred over to the cooler and fermentation kettle. The user must also add in the grains and hops into the different kettles depending on what stage of the brewing process they are in manually.

2.2 External Inputs & Outputs

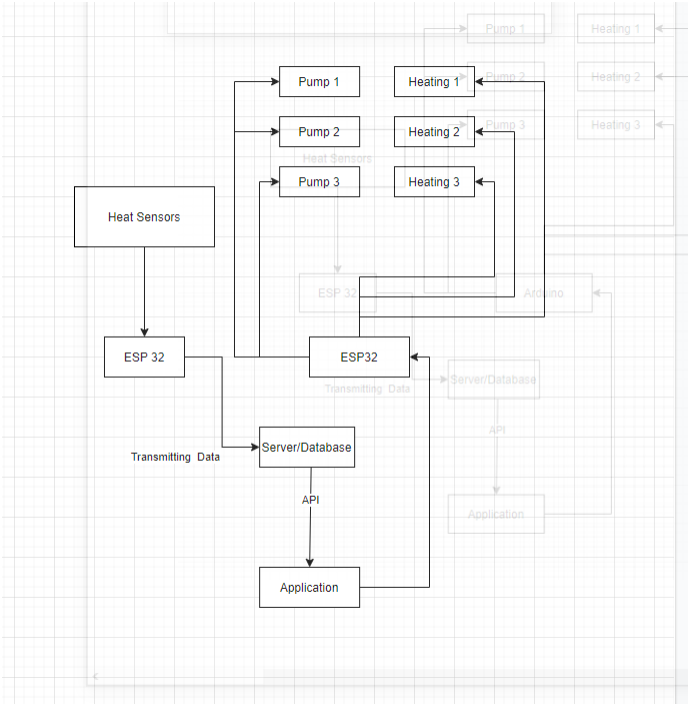

Figure 3: Data Flow and Control

The Back Burner Brew will utilize multiple ESP32's. The ESP32 will be used for reading the temperatures of the different kettles and the Arduino will be used to control the heating elements and the pumps as well.The ESP32 will read the temperatures of HLT and the mash tun and send them to web server. Once the data has been received by the server, the server will then display that data to the user on the web application. The server will also be able to tell the ESP32 which heating element must be turned on to maintain the desired temperature and which pump to turn on as well.

2.3 Product Interfaces

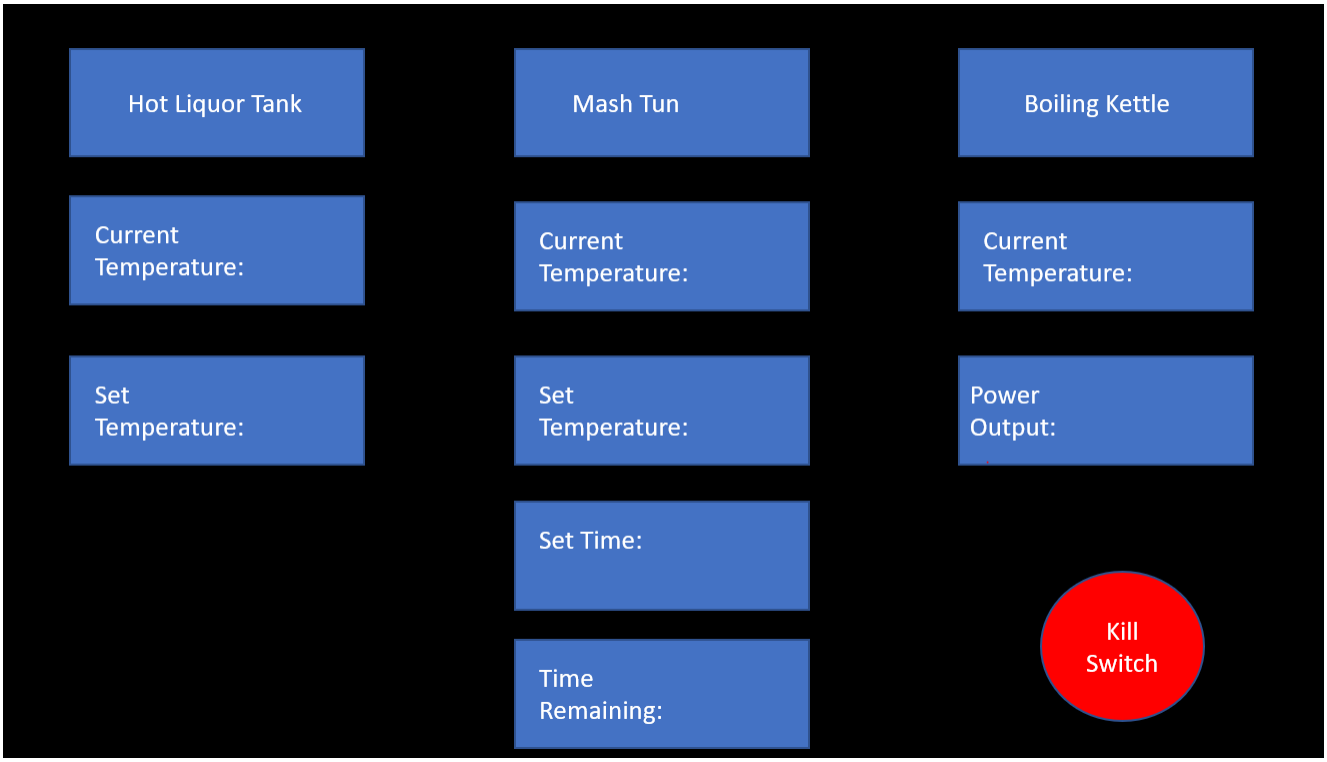

Figure 4: Web Interface Template

The Back Burner Brew user interface template can be seen in the figure above. The web application will allow the user to set the temperature of both the HLT and the Mash Tun and will display the current temperatures as well. The mash tun will also allow for the user to enter the amount of time the mashing process will take, while also displaying the remaining time left on that process. The boiling kettle does not let the user control the temperature of the boiling kettle, rather, it lets the user control the power output of the boiling kettle and they must monitor the temperature of theboiling kettle themselves.

3 Customer Requirements

The user should expect to input desired commands, controls, and specific settings such as temperature and length of time by a easily accessible touchscreen. The touchscreen will be attached to a Raspberry Pi that will handle communications between the user and the various sensors and heating elements. The user can expect that whichever temperature they set for their desired application, that the temperature will remain constant.

3.1 Touchscreen Control System

3.1.1 Description

The user needs a way to be able to input commands and specific settings before starting the beer brewing process. This will be done by attaching a touchscreen to a Raspberry Pi 4. The Raspberry Pi will then communicate with the automated brewing system through a webserver that is hosted by the various microcontrollers that manage various sensors.

3.1.2 Source

This requirement came from Dr. Chris Conly. He requested that our team have a method by which the user can interface with the automated brewing system and input various commands, controls, and recipe specific settings.

3.1.3 Priority

This feature is of **Critical** priority. Without this feature the user would be unable to make the automated brewing system produce the user's desired results.

3.2 Programmable HLT Heating Element Temperature Management

3.2.1 Description

The heating element on the HLT will need to maintain the temperature that is set by the user via the main control touchscreen. The reason for customizable temperature is due to the varying temperature requirements set by the recipe chose by the user. This temperature control will managed by an ESP32 microcontroller. The temperature of the vessel will be monitor by a DS18B20 digital thermometer. The microcontroller will take continuous readings from the thermometer. When it begins dropping below the desire temperature the microcontroller will send a signal to a mosfet. When the mosfet receives that signal it switch states and allow for power to be delivered to the heating element. Once the desired temperature is reached, the microcontroller will send another signal to the mosfet. The mosfet will then turn off, and this would turn off the power to the heating element.

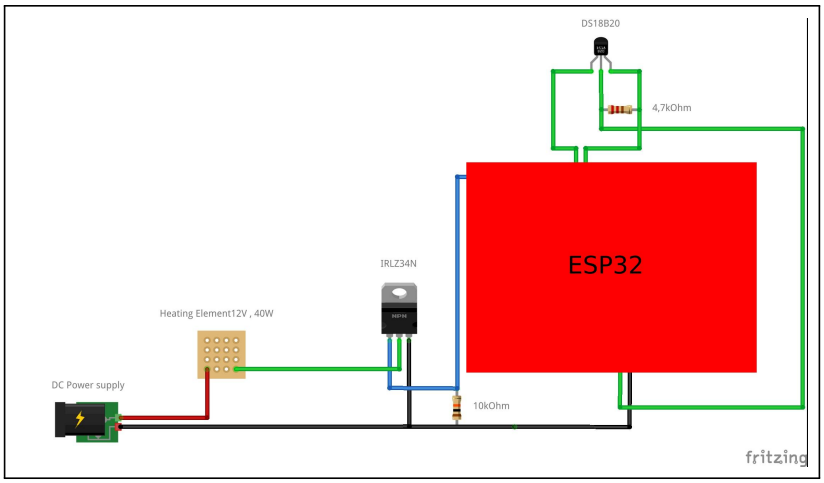

Figure 5: HLT Temperature Controller Diagram

3.2.2 Source

This requirement came from Dr. Chris Conly. He requested that our team enable the user to be able to set a specific temperature via the main control touchscreen. The water is to stay at a constant boiling temperature to maximize effectiveness of the mashing process.

3.2.3 Standards

- IEC 60730
- IEC 60335
- EN ISO 13849

3.2.4 Priority

This feature is of **Critical** priority. Without this feature we would be unable to accomplish an effective mashing process.

3.3 Boiling Kettle Heating Element Temperature Management

3.3.1 Description

The heating element on the boil vessel will need to maintain a water temperature of 212 degrees fahrenheit for optimal extraction. This temperature control will managed by an ESP32 microcontroller. The temperature of the vessel will be monitor by a DS18B20 digital thermometer. The microcontroller will take continuous readings from the thermometer. When it begins dropping below the desire temperature the microcontroller will send a signal to a mosfet. When the mosfet receives that signal it switch states and allow for power to be delivered to the heating element. Once the desired temperature is reached, the microcontroller will send another signal to the mosfet. The mosfet will then turn off, and this would turn off the power to the heating element.

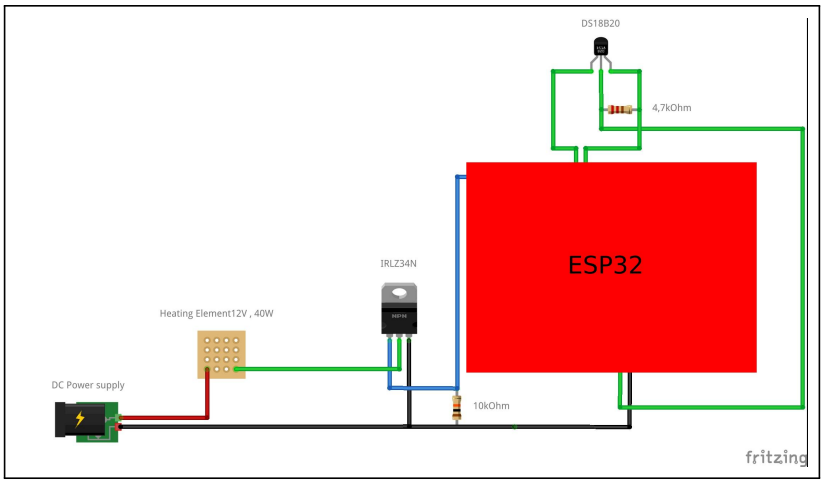

Figure 6: Boiling Kettle Temperature Controller Diagram

3.3.2 Source

This requirement came from Dr. Chris Conly. He requested that our team ensure that the water stay a constant boiling temperature to maximize extraction.

3.3.3 Constraints

Detailed description of applicable constraints...

3.3.4 Standards

- IEC 60730
- IEC 60335
- EN ISO 13849

3.3.5 Priority

This feature is of **Critical** priority. Without this feature we would be unable to accomplish any sort of extraction.

4 Packaging Requirements

Include a header paragraph here. Packaging requirements are those requirements that identify how the delivered product will be packaged for delivery to the end-user; or how it will "look" when finished and delivered. For example, you might specify that the software required for operation will be pre-loaded on the hard drive, delivered on CD/DVD, or available via download. Software might be customer installable, or not, etc. Hardware components could be all in a single package, provided as a "bag of parts" to be assembled/installed by the user, painted a certain color, logos affixed, etc. Care should be taken not to duplicate requirements found in other sections of this document.

4.1 Requirement Name

4.1.1 Description

Detailed requirement description...

4.1.2 Source

Source

4.1.3 Constraints

Detailed description of applicable constraints...

4.1.4 Standards

List of applicable standards

4.1.5 Priority

Priority

5 Performance Requirements

This section will provide performance requirements to maximize the quality of beer that is produced through this project. The performance requirements are response time of micro-controllers, sufficient power supply

5.1 Response time of micro-controllers

5.1.1 Description

Since the micro-controller using for the brewing system needs to read data from several thermometers in tanks and communicate with a web server to provide a monitoring system, and control pumps, at least ESP32 or higher spec is required. The micro-controller has to follow a specific recipe including the temperature of the hot liquor tank and the mash tun, and time for brewing, etc. Fast response time is necessary to take instance reaction based on data read from the brewing equipment, manage communication with web server, and an internet connection.

5.1.2 Source

Source

5.1.3 Constraints

A monitor connected to ESP32 or higher spec micro-controllers is required for many purposes such as developing software, take immediate action if needed, etc.

5.1.4 Standards

Non-applicable.

5.1.5 Priority

Top-priority should be given as this is core equipment out of entire system.

5.2 sufficient power supply

5.2.1 Description

The time it takes to produce beer to go from raw materials to finished, ready-to-drink beer depends on a number of different factors; however, the typical Light Ales like Cream Ale and Honey Kolsch take a minimum of one week. Other drinks such as Amber Ales, Dark Ales, Light Lagers, and Dark Lagers take much longer to make. While brewing, the equipment has to stay up and keeps exchanging data between a web server. A sufficient power supply is required to keep the equipment and the micro-controller running.

5.2.2 Source

Basic electrical hazards and safety measures

5.2.3 Constraints

Constant checking for electricity is required to prevent any issue related to electricity.

5.2.4 Standards

Non-applicable.

5.2.5 Priority

Top-priority should be given.

6 Safety Requirements

Include a header paragraph specific to your product here. Safety requirements might address items specific to your product such as: no exposure to toxic chemicals; lack of sharp edges that could harm a user; no breakable glass in the enclosure; no direct eye exposure to infrared/laser beams; packaging/grounding of electrical connections to avoid shock; etc.

This section will provide brief explanation on safety requirement while using this product. There are various risk factors included while operating the Brewing system. Since we are dealing with electrical appliances, there is always a risk of getting electrocuted if proper attention is not given.

6.1 Safety Hazards while Working with the Electricity

6.1.1 Description

Different electrical appliances like electric heater will be used in this project alongside with water. Even a small misplaced or leakage of water into the micro controller can damage it and can put the user in electrical hazards. While working with mash, it is important to note how hot the mash is in order to prevent burn.

6.1.2 Source

A basic safety measure taken while working with any electrical appliances, especially when a liquid is nearby.

6.1.3 Constraints

The product must be built closed to a place where there is electrical plugs. Once built, the product can be difficult and time-consuming to move. The user should be present at the site while brewing at first for some batches to make sure everything is running smoothly.

6.1.4 Standards

Non-applicable.

6.1.5 Priority

Top-priority should be given as this is concerned with the health of the user.

7 Maintenance & Support Requirements

Include a header paragraph specific to your product here. Maintenance and support requirements address items specific to the ongoing maintenance and support of your product after delivery. Think of these requirements as if you were the ones who would be responsible for caring for customers/end user after the product is delivered in its final form and in use "in the field". What would you require to do this job? Specify items such as: where, how and who must be able to maintain the product to correct errors, hardware failures, etc.; required support/troubleshooting manuals/guides; availability/documentation of source code; related technical documentation that must be available for maintainers; specific/unique tools required for maintenance; specific software/environment required for maintenance; etc.

7.1 Requirement Name

7.1.1 Description

Detailed requirement description...

7.1.2 Source

Source

7.1.3 Constraints

Detailed description of applicable constraints...

7.1.4 Standards

List of applicable standards

7.1.5 Priority

Priority

8 Other Requirements

Include a header paragraph specific to your product here. In this section specify anything else that is required for the product to be deemed complete. Include requirements related to customer setup and configuration if not specified in a previous requirement. Add any known requirements related to product architecture/design, such as modularity, extensibility (for future enhancements), or adaptation for a specific programming language. Consider requirements such as portability of your source code to various platforms (Windows, Linux, Unix Mac OS, etc.).

8.1 Requirement Name

8.1.1 Description

Detailed requirement description...

8.1.2 Source

Source

8.1.3 Constraints

Detailed description of applicable constraints...

8.1.4 Standards

List of applicable standards

8.1.5 Priority

Priority

9 Future Items

In this last section, you will reiterate all requirements that are listed as priority 5. This is repetitive, but necessary as a concise statement of features/functions that were considered/discussed and documented herein, but will NOT be addressed in the prototype version of the product due to constraints of budget, time, skills, technology, feasibility analysis, etc. Use the following format for this section.

9.1 Requirement Name

9.1.1 Description

Detailed requirement description...

9.1.2 Source

Source

9.1.3 Constraints

Detailed description of applicable constraints...

9.1.4 Standards

List of applicable standards

9.1.5 Priority

Priority

REFERENCES