

**DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
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**SYSTEM REQUIREMENTS SPECIFICATION
CSE 4316: SENIOR DESIGN I
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**EARTH WISE
SMART GREEN HOUSE**

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1 PRODUCT CONCEPT

This section describes the purpose, use and intended audience for the smart greenhouse hub along with its mobile application. Users of this hub will be able monitor and garden their plants in the hub using mobile application.

1.1 PURPOSE AND USE

Our greenhouse hub should be able to maintain certain level of temperature, light, humidity and soil moisture. The hub should also be able to self regulate the irrigation system within time frame set by user if needed. Also the mobile application will provide users an interface to monitor the current greenhouse condition and change the setting if they want to. The mobile application should be able to remotely connect to greenhouse hub and allow users to make temperature, light, moisture settings and change time frame for irrigation as well.

1.2 INTENDED AUDIENCE

The intended audiences for this smart greenhouse hub are general public. The users are not required to have any specific technical knowledge about the product and the application interface will be fairly simple so that everyone can use it. The product is specially targeted to people who love gardening but do not have enough time for it. These group of people can hugely benefit from our product as they can garden with their phone from any corner.

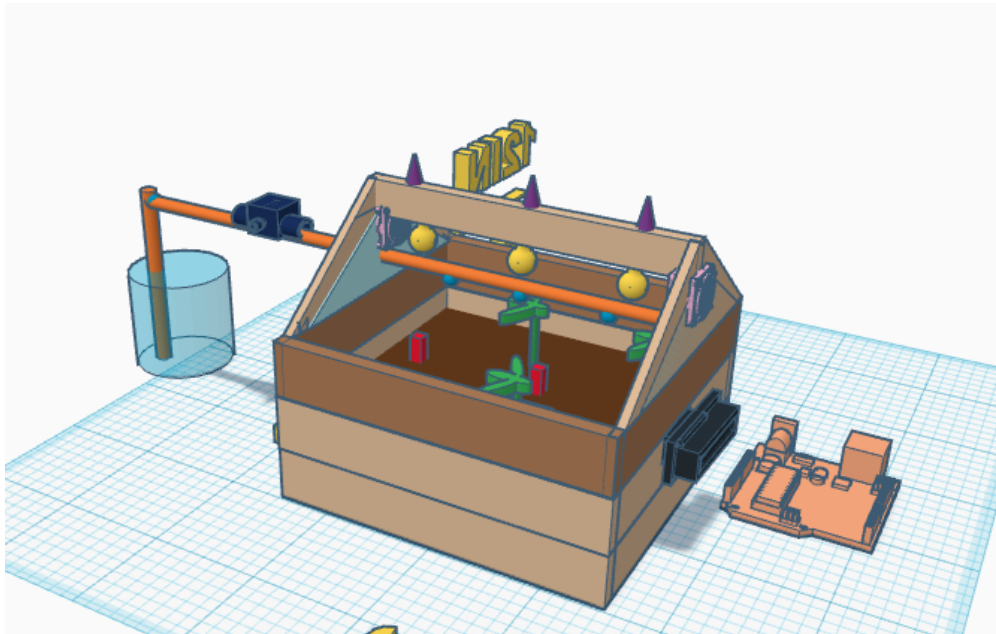


Figure 1: Smart Green House conceptual drawing

2 PRODUCT DESCRIPTION

This section provides the reader with an overview of Smart Green House. The primary operational aspects of the product, from the perspective of end users, maintainers and administrators, are defined here. The key features and functions found in the product, as well as critical user interactions and user interfaces are described in detail.

2.1 FEATURES & FUNCTIONS

The product will do the following:

- Water small plants when the soil moisture is low
- Control the inside temperature
- Control the light for small plants when the plants can't get enough sunlight
- Inform users environment settings inside the greenhouse by an Android app
- Be set up the environment settings when growing certain plants by an Android app
- Be remotely controlled by an Android app
- Notify potential problems to users by an Android app

The product will not do the following:

- Water big plants which are higher 25 inches
- Grow more than 7 plants
- Be controlled without an Android app

2.2 EXTERNAL INPUTS & OUTPUTS

Input/Output	Name	Description	Use
Input	Moisture Level	Soil moisture threshold for watering plants	To set up the soil moisture threshold in order to water the plants.
Input	Humidity Level	Humidity level inside the green house	To set up a desired humidity level users want the green house to be
Input	Light Duration	Light duration which the plants has been exposed to the sunlight	To set up a desired light duration an user want the plants to absorb
Input	Temperature	Temperature inside the green house	To set up a desired Temperature an user want the green house to be
Input	Time Range	Time range when to water plants	To set up a desired time range an user want water plants in the green house
Output	Irrigation System	A watering system - including a water pump, sprinkler heads, water container, and pipe - that hanging from the top of the green house	To water the plants inside the green house when needed
Output	Heater	A electrical heater	To warm up the green house during the low temperature
Output	Pump	A water pump	To change current temperature, humidity, and moisture level inside the green house

2.3 PRODUCT INTERFACES

Earth Wise users can use the application to monitor the current conditions in the greenhouse as well as remotely control the watering, temperature, and lighting systems. The application will have a screen where the current temperature, light and moisture levels in the greenhouse will be displayed at the top. At the center of the screen, four buttons will be used to turn on the watering system, lights, and heating and cooling systems. Near the bottom of this screen, a button will be placed to redirect users to the guide screen where they can choose from a list of predefined environment settings. Lastly, this screen will have a button on the top right corner where users can report any bugs they encounter when using the application.

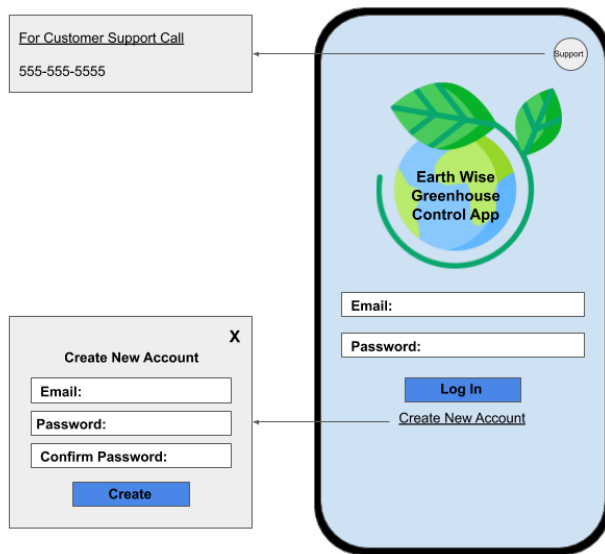


Figure 2: Login Screen Conceptual Interface

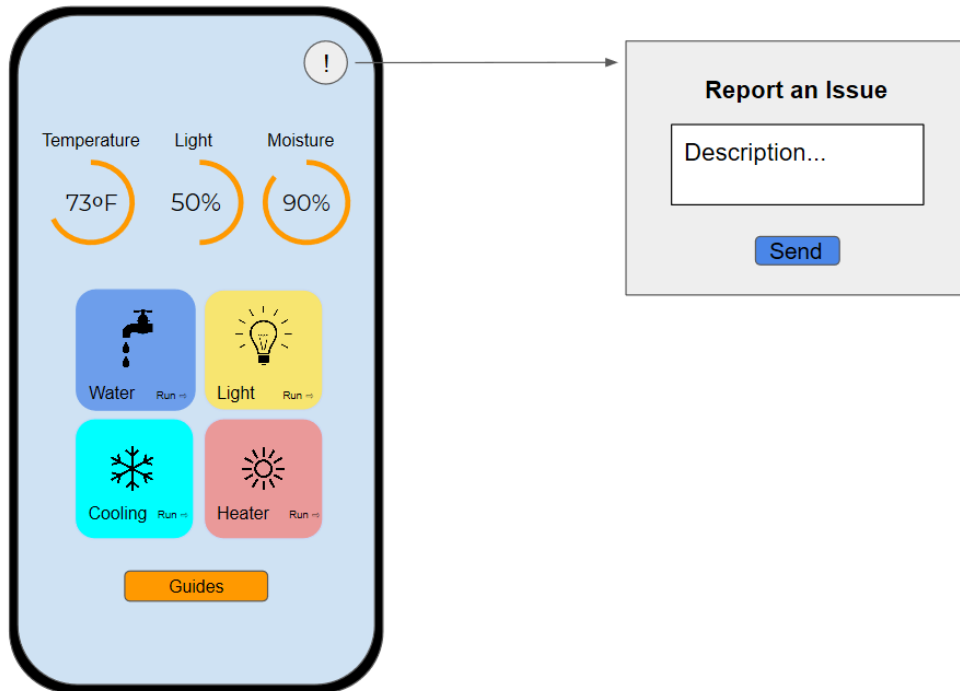


Figure 3: Data Display Conceptual Interface

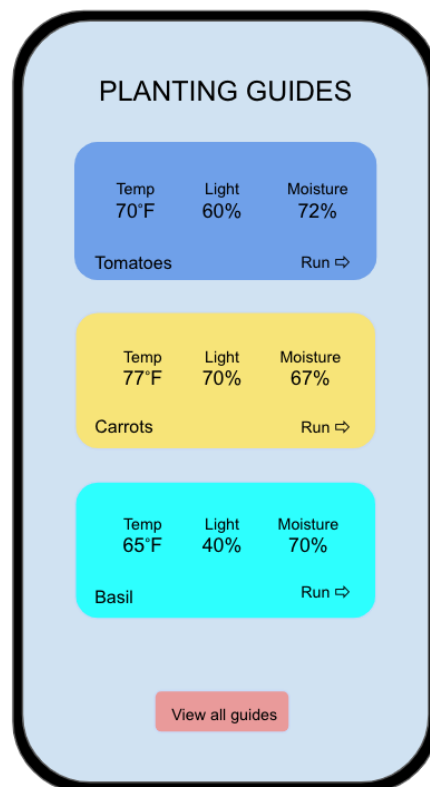


Figure 4: Guides Conceptual Interface

3 CUSTOMER REQUIREMENTS

Our project consists of a smart greenhouse hub and an android application to control the hub. The users can expect the hub to self regulate itself once they adjust all essential settings for the greenhouse. Although the greenhouse hub is self automated, the users can't expect the hub to do everything on its own and not pay any attention at all. The hub will need user assistance whenever the water reservoir is low or whenever hub runs into any technical issue. The users can also expect the android application to be relatively simple and will allow them to connect to greenhouse hub through WiFi.

3.1 WATERING

3.1.1 DESCRIPTION

The Smart Green House will active the irrigation system when the soil moisture level is low within the time range based on the user settings of an Android app.

3.1.2 SOURCE

Duy Nguyen

3.1.3 CONSTRAINTS

- To water plants, water container needs to have water.

3.1.4 STANDARDS

N/A

3.1.5 PRIORITY

Critical

3.2 AUTOMATION

3.2.1 DESCRIPTION

The Smart Green House will allow the user to select specific environment settings based on the type of plant. Once the settings have been approved, the green house will constantly maintain all settings until user specifies otherwise or until the planting session is complete.

3.2.2 SOURCE

Walter Mkpanam

3.2.3 CONSTRAINTS

- The user will need to monitor plants physically as the system does not account for data on plant changes.
- Once environment settings and planting duration are approved, the system will follow those settings precisely without making changes unless the change is in relation to stabilising pre-approved environment settings.

3.2.4 STANDARDS

N/A

3.2.5 PRIORITY

High

3.3 ENVIRONMENT SETTINGS DISPLAY

3.3.1 DESCRIPTION

The greenhouse will use a light sensor, moisture sensor, and temperature sensor which will continuously record the environment conditions inside the greenhouse. These recordings will be displayed on an LCD display outside the greenhouse and will be simultaneously cast to a mobile application in real-time.

3.3.2 SOURCE

Andrea Rivera

3.3.3 CONSTRAINTS

- The moisture, light and temperature sensors must all be installed correctly and maintained in order for them to give correct readings.

3.3.4 STANDARDS

N/A

3.3.5 PRIORITY

High

3.4 TEMPERATURE ADJUSTMENT

3.4.1 DESCRIPTION

The greenhouse will continuously monitor the temperature inside the greenhouse. The heating and cooling system will be utilized by greenhouse to maintain the particular temperature set by the user through an android application.

3.4.2 SOURCE

Paras Shrestha

3.4.3 CONSTRAINTS

- The greenhouse temperature must be set by user so that greenhouse can work to maintain that temperature.

3.4.4 STANDARDS

N/A

3.4.5 PRIORITY

High

3.5 HUMIDITY ADJUSTMENT

3.5.1 DESCRIPTION

The greenhouse will continuously monitor the humidity inside the greenhouse. The dehumidifying system will be utilized by greenhouse to maintain the particular humidity set by the user through an android application in order to prevent fungus or other diseases of the plants.

3.5.2 SOURCE

Duy Nguyen

3.5.3 CONSTRAINTS

- The greenhouse humidity must be set by user.

3.5.4 STANDARDS

N/A

3.5.5 PRIORITY

High

3.6 LIGHT SETTING

3.6.1 DESCRIPTION

The greenhouse will continuously monitor light conditions outside greenhouse and change the intensity of light bulbs making sure light percentage is always above the level set by user.

3.6.2 SOURCE

Paras Shrestha

3.6.3 CONSTRAINTS

- The user must set the minimum light percentage through an application.
- The LED's must be dimmable.

3.6.4 STANDARDS

N/A

3.6.5 PRIORITY

Moderate

3.7 EMERGENCY NOTIFICATIONS

3.7.1 DESCRIPTION

The greenhouse system will notify the user through the application and LED screen(mounted on the greenhouse system) any emergency that affects the system's performance.

3.7.2 SOURCE

Walter Mkpanam

3.7.3 CONSTRAINTS

- There must be a defined emergency that would cause the system to perform below requirement expectations.
- The defined emergency could most likely be a fault with one of the hardware components.

3.7.4 STANDARDS

N/A

3.7.5 PRIORITY

High

3.8 SOLAR BATTERY

3.8.1 DESCRIPTION

The greenhouse will charge an external battery by the sun light, so the green house can use that battery during power outage.

3.8.2 SOURCE

Duy Nguyen

3.8.3 CONSTRAINTS

- Solar battery can only provide the electricity for the green house components in a period of time.

3.8.4 STANDARDS

N/A

3.8.5 PRIORITY

Future

4 PACKAGING REQUIREMENTS

The package should include all components of greenhouse and a very clear and detailed instruction manual on how to assemble the hub. The mobile application associated with hub will not be the part of package but the manual should provide a link or QR code for the users to download the application. The software needed for the hub will be pre-loaded on the arduino that is included with the package.

4.1 INSTRUCTION MANUAL

4.1.1 DESCRIPTION

A set of instructions about the included components, functionality of the green house, and step by step instructions detailing the assembly and setup of the users own greenhouse. Should also include any safety warnings that are necessary as well as contact info in case customer experiences problems with the product.

4.1.2 SOURCE

Chris Jones

4.1.3 CONSTRAINTS

- Assembly instructions should be presented such that the customer can understand each step within 2 min or reading.
- Total size of the manual will be big enough to only contain the necessary information described in the description.
- Manual will provide instructions for building a small greenhouse, but it must be made clear that the components will not be provided in the product.

4.1.4 STANDARDS

Fair Packaging and Labeling Act

4.1.5 PRIORITY

Critical

4.2 SPECIFY PRODUCT SOLD

4.2.1 DESCRIPTION

The packaging and product descriptions of this product must make it clear that it only includes the system for controlling and monitoring the environment of a greenhouse and does not actually include the materials to make a greenhouse.

4.2.2 SOURCE

Chris Jones

4.2.3 CONSTRAINTS

- Text on packaging or the product must state this is a greenhouse management system, and not a greenhouse.
- Text in product descriptions must state that this is a greenhouse management system, and not a greenhouse.
- Text on packaging must list all components included in the kit.
- Text in product descriptions must list all components included in the kit.

4.2.4 STANDARDS

Fair Packaging and Labeling Act

4.2.5 PRIORITY

Critical

5 PERFORMANCE REQUIREMENTS

The overall performance of the greenhouse hub depends on two aspects: how physical greenhouse performs and how reliable the database and application end is. The application running on the user's phone and arduino must have consistent connection with database so that they can see current data and make changes if necessary in real time. The hardware should also be well programmed making sure that it can give quick responses to any changes in the data.

5.1 PUMPING RATE AND DURATION

5.1.1 DESCRIPTION

The pump will be activated for bursts of 5 seconds separated by 30 seconds to allow the water to soak into the soil.

5.1.2 SOURCE

Paras Shrestha

5.1.3 CONSTRAINTS

- The moisture level must be rechecked after every burst is soaked into soil to see if further watering is required. This is critical to avoid flooding inside the greenhouse and side effects of over-watering.

5.1.4 STANDARDS

N/A

5.1.5 PRIORITY

Critical

5.2 POWER SOURCE

5.2.1 DESCRIPTION

The arduino will be powered using power outlet. The voltage should be within 7-12 volts range and the current should be in the range of 500mA to 1A.

5.2.2 SOURCE

Paras Shrestha

5.2.3 CONSTRAINTS

- A DC adapter must be used while powering arduino from the outlet as arduino does not work with AC power.
- Although arduino supports up to 20V, voltage must not exceed 12V as it can cause overheating and damage the chip.
- Any voltage less than 5 Volts may cause the board to be unstable.

5.2.4 STANDARDS

N/A

5.2.5 PRIORITY

Critical

5.3 WiFi RANGE

5.3.1 DESCRIPTION

Arduino need to catch the WiFi in the range of 500 feet from the WiFi router.

5.3.2 SOURCE

Duy Nguyen

5.3.3 CONSTRAINTS

- The WiFi router need to be close to the arduino when arduino is outside the house.

5.3.4 STANDARDS

N/A

5.3.5 PRIORITY

High

5.4 CONSISTENT CONNECTION

5.4.1 DESCRIPTION

After setting up the WiFi name and password from a user, Arduino need to connect to the WiFi and reconnect to the WiFi when the connection is lost.

5.4.2 SOURCE

Duy Nguyen

5.4.3 CONSTRAINTS

- The WiFi router need to be close to the arduino when arduino is outside the house.
- The user need to provide WiFi name and password

5.4.4 STANDARDS

N/A

5.4.5 PRIORITY

Critical

5.5 MOISTURE SENSOR

5.5.1 DESCRIPTION

Sensor will measure the amount of water in the soil, when the reading is below the threshold set by user, Arduino will prompt the watering system.

5.5.2 SOURCE

Andrea Rivera

5.5.3 CONSTRAINTS

- Sensor will need to be properly placed within the soil and maintained to ensure accurate moisture readings.

5.5.4 STANDARDS

N/A

5.5.5 PRIORITY

Critical

5.6 LIGHT SENSOR

5.6.1 DESCRIPTION

Sensor will monitor the amount of light the plant receives, when the reading is below the total amount of light the plant needs for 24 hours, the Arduino will prompt the lighting system to turn on.

5.6.2 SOURCE

Andrea Rivera

5.6.3 CONSTRAINTS

- Sensor needs to be completely exposed to sunlight or it may give inaccurate light exposure readings.

5.6.4 STANDARDS

N/A

5.6.5 PRIORITY

Critical

5.7 TEMPERATURE SENSOR

5.7.1 DESCRIPTION

Sensor will continuously monitor the temperature inside the greenhouse, if the temperature falls below or goes above the temperature threshold set by user, the Arduino will prompt the cooling or heating system.

5.7.2 SOURCE

Andrea Rivera

5.7.3 CONSTRAINTS

- Sensor must be properly set and maintained to give accurate readings.

5.7.4 STANDARDS

N/A

5.7.5 PRIORITY

Critical

5.8 SMOKE SENSOR

5.8.1 DESCRIPTION

The smoke sensor will monitor the concentration of smoke in air. When the concentration of smoke reaches a dangerous level that can be an indication of a fire breakout, sprinkler system is activated.

5.8.2 SOURCE

Paras Shrestha

5.8.3 CONSTRAINTS

- The sensor must calibrated almost to perfection so that case of fire hazard can be accurately determined.

5.8.4 STANDARDS

N/A

5.8.5 PRIORITY

Critical

6 SAFETY REQUIREMENTS

As the greenhouse hub consists of lots of electrical components, safety measures are vital to avoid any unfortunate events. The components must be handled well and assembled in the right way to ensure the safety. The electrical components must not be placed together in a way they can interfere with each other and safe distance must be maintained. Also, the application end must be well protected to avoid any unauthorized access to the greenhouse hub.

6.1 FIRE HAZARD

6.1.1 DESCRIPTION

In case of an unfortunate fire hazard, the sprinkler system should be activated.

6.1.2 SOURCE

Paras Shrestha

6.1.3 CONSTRAINTS

- The arduino must be well programmed to consider values from temperature sensor and smoke sensor and correctly determine the case of fire.

6.1.4 STANDARDS

N/A

6.1.5 PRIORITY

Critical

6.2 AUTHENTICATION

6.2.1 DESCRIPTION

Users should provide username and password in the android app in order to control the green house.

6.2.2 SOURCE

Duy Nguyen

6.2.3 CONSTRAINTS

- The android app needs to use a third party - Firebase to store user credentials.

6.2.4 STANDARDS

N/A

6.2.5 PRIORITY

Low

6.3 HEATER POSITIONING

6.3.1 DESCRIPTION

The heater used to control temperature in the greenhouse must be positioned at least 5 inches away from other hardware components.

6.3.2 SOURCE

Walter Mkpanam

6.3.3 CONSTRAINTS

- User must ensure heater is properly positioned according to manufacturer recommendations to avoid any harm to other critical components of the greenhouse system.

6.3.4 STANDARDS

N/A

6.3.5 PRIORITY

High

7 MAINTENANCE & SUPPORT REQUIREMENTS

The greenhouse hub will be accompanied by an android application. The application will provide users a way to report the android application bug or any hardware issues and malfunctions. The application bug can be fixed remotely while some hardware issues might need users to schedule an appointment with technicians.

7.1 ANDROID APP BUG REPORTING

7.1.1 DESCRIPTION

This is a way for users to report all bugs encountered in the android app to the developers. Feedback will be stored in a database and updates will developed for the android app to further improve the customers experience.

7.1.2 SOURCE

Chris Jones

7.1.3 CONSTRAINTS

- A button will be available in the android application allowing the customer to send feedback.
- Before attempting to fix a reported bug, the bug must first be recreated on the developers side.

7.1.4 STANDARDS

N/A

7.1.5 PRIORITY

High

7.2 HARDWARE ERROR REPORTING HOT-LINE

7.2.1 DESCRIPTION

Direct phone line to contact technicians about problems that may arise with the hardware. May schedule technicians to come in and fix hardware issues.

7.2.2 SOURCE

Andrea Rivera

7.2.3 CONSTRAINTS

Hot-line will not be available 24/7.

7.2.4 STANDARDS

N/A

7.2.5 PRIORITY

Low

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

The prototype greenhouse hub will be powered using power outlet but the future versions can be developed with solar battery. The prototype will not be getting solar batteries because of budget limitations and time constraint but there is room for development if possible in future.

9.1 SOLAR BATTERY

9.1.1 DESCRIPTION

The greenhouse will charge an external battery by the sun light, so the green house can use that battery during power outage.

9.1.2 SOURCE

Duy Nguyen

9.1.3 CONSTRAINTS

Solar battery can only provide the electricity for the green house components in a period of time.

9.1.4 STANDARDS

N/A

9.1.5 PRIORITY

Future

9.2 BATTERY HAZARD

9.2.1 DESCRIPTION

There is a possibility the battery could be damaged due to external factors and will cause a hazard for the greenhouse and the user.

9.2.2 SOURCE

Walter Mkpanam

9.2.3 CONSTRAINTS

- Keep the battery in a safe and dry area to prevent any harm such as making the battery a shock or explosive hazard.

9.2.4 STANDARDS

N/A

9.2.5 PRIORITY

Future

REFERENCES