FOREST FIRE DETECTION SYSTEM

Quad Core Crew

Version 1.0

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Test Plan Document

Version 1.0

Contents

A. Introduction

1. Purpose of the Test Plan Document

The purpose of the test plan document for the “Wildfire” device is to outline the testing approach of the device. The document will specify what will be tested in our device and why it will be tested. The document will also include testing objectives and rationale, as well as the scope and limitations of the test plan. The testing of individual components as well as systems in our device will aid in error checking and in verifying the functionality of components and systems.

B. Functional Testing

1. Test Risks/Issues

When conducting tests on the “Wildfire” device, there will be a potential fire hazard. To simulate a good environment to test the device, a burning fire must be present by the device. To mitigate risk, the fire burning will be controlled inside a grill or similar heat resistant receptacle. This will be done outdoors in an area of low vegetation, to prevent wildfire. A fire extinguisher or water bucket will also be present, need be just in case the fire gets out of control. A five-foot radius around the fire will be visibly marked off to prevent anyone from accidentally getting too close to the fire. The device will use the smoke and heat of the fire to trigger the functionality.

2. Items to be Tested/Not Tested

Item to Test	Test Description	Test Date	Responsibility
Photoelectric sensor	The sensor will be placed next to a burning fire. This should trigger the fire alarm, and the trigger will be verified on the Arduino serial console. The trigger will also be verified on the database once the trigger gets pushed to the database over cellemetry.		Luis Guevara
GPS module	The GPS module will be interfaced to the microcontroller. Code will be run on the microcontroller, then the module should return the location, which will be verified by the serial console. The location will also be verified on the database once the location gets pushed to the database over cellemetry.		Luis Guevara
GSM module	Code interfacing the GSM module and an API for location services will be run on the microcontroller. The GSM module should return the location, which will be verified by the serial console. The location will		Luis Guevara

	also be verified on the database once the location gets pushed to the database over cellemetry.		
Query Debugging	The device will be connected to a computer via USB. A command will be entered to the Arduino serial console, that will engage the debugging mode. The console should display readings for all sensors. If any sensors are out of range, that means it is malfunctioning.		Luis Guevara
User subscribing to Push Notifications	Create a user account, click on Subscribe Page, enter phone number, receive sign-up text confirmation.		Edwin Hernandez
User receiving Push Notifications	Add a new device object in the database, set alert value to 1-or-2, receive text message about which device detected a potential-fire/fire.		Edwin Hernandez
Display Device(s) Data on Map (Home Page)	Add a new device object in the database, wait for 1-2 minutes for Home page to update.		Edwin Hernandez
Display Device(s) Data on Admin Page	Add a new device object in the database, wait for 1-2 minutes for Admin page to update.		Edwin Hernandez
Display Sensor Issues on Admin Page	Add a new device object in the database with invalid sensor values, wait for 1-2 minutes for Admin page to update.		Edwin Hernandez
Ionization Sensor	The ionization sensor will be placed next to the burning fire. This should trigger the fire alarm and send a voltage change to the Arduino console. This trigger should also be verified over cellemetry.		Lluviana Vasquez
Camera	The camera will be placed to look outside the box and will be triggered once it receives a change in voltage from the sensors. It will record a video of the wildfire and send a recording to the cloud.		Lluviana Vasquez

GSM Module (Data)	Device software will collect data from the sensors, calculate the presence of fire, and transmit that information to the database without error. This will be tested by comparing the sensor values on the website UI, database table records, and actual values from the serial CLI.		Matthew Wilson
Temp/Humidity Sensor	The software will sense the temperature and humidity using this sensor. This will be tested by comparing the values reported from the website UI / serial CLI to the actual ambient temp and humidity using a thermometer and hygrometer.		Matthew Wilson
Active Cooling Fan	The fan will circulate outside air through the enclosure over the sensors and processor for cooling and to provide new air samples to be tested for traces of a wildfire. This will be tested by placing a heat source near the heat sensor and observing the fan speed reaction.		Matthew Wilson
Anemometer	The anemometer will record the wind speed. This will be tested using real wind and wind generated by a fan.		Matthew Wilson
Wind Vane	The wind vane will record the wind direction. This will be tested by using a fan to change the wind direction blowing on the wind vane.		Matthew Wilson

3. Test Approach(s)

A controlled fire will be deployed on a grill or fireproof receptacle, causing smoke and combustion particles to be released. The device will be in the presence of smoke and combustion particles. The smoke and temperature of the fire should trigger the functionality of the device, as the smoke and temperature can be thought of as the input. Using these inputs, each module and sensor's functionality will be tested. After the sensors and modules are tested and triggered, the microcontroller will send the data of the sensors over cellemetry to the database. The data will be looked at on the website and verified to make sure it is within realistic parameters.

4. Test Cases

Photoelectric sensor

Description: The photoelectric sensor will be exposed to smoke. The presence of smoke is the input that will drive the sensor. When the sensor activates, it will set a flag in the code that will be sent to the database over cellemetry, indicating that the photoelectric sensor has been triggered.

GPS Module

Description: The GPS module will be outdoors, tracking the location of the device using satellites. These satellites will provide the input to the GPS module. The GPS module and microprocessor will translate the inputs into readable coordinates, which will then be pushed to the database over cellemetry.

GSM Module

Description: The GSM module will be outdoors, tracking the location of the device using cell towers. These cell towers will provide the input to the GSM module. The GSM module and microprocessor will translate the inputs into readable coordinates, which will then be pushed to the database over cellemetry.

Query Debugging

Description: The troubleshooter will plug in their computer to the device, and open an Arduino serial console. The user will then input a command into the serial console, which will be read by the device. The device will then output into the serial console the readings of the sensors.

User subscribing to push notifications

Description: The user needs an account to subscribe for push notifications. They will navigate to the subscribe page, enter phone number, and submit. They will then receive a confirmation text message and the database will be updated with the new data.

User receiving push notifications

Description: The user needs to have an account and subscribe for push notifications. When new device data is being pushed to the database, a lambda function will check the alert value and if it's 1 or 2, it will send a text message to all subscribers based on the associated alert value.

Display Device(s) Data on Map

Description: When a user/non-user loads the home page, it will fetch the device data and display it on the map. Every 60 seconds, the map will be updated.

Display Device(s) Data on Admin Page

Description: When a troubleshooter loads the admin page, it will fetch the device data and display the data. Every 60 seconds, the data will be updated.

Display Sensor Issues on Admin Page

Description: When a trouble shooter loads the admin page, it will fetch the device data and display the data. Every 60 seconds, the data will be updated and validated when a function that checks each sensor values. From there, a message will be displayed with the associated device that has out-of-bound values.

Ionization sensor

Description: The ionization sensor will be exposed to smoke. Once it detects the smoke, there will be a voltage change within the sensor. This sensor will then trigger the camera and cause it to start video recording.

Camera

Description: The camera will be used as a video recording device that will be able to store videos onto an SD card and then send them to the cloud. It will only switch on when the sensors alert it that there is a wildfire nearby. During nighttime, the camera will have IR LEDs that will begin to illuminate for visibility.

Pushing sensor readings to the cloud

Description: After a set amount of time, the GSM module will transmit the sensor data to the cloud database to be used on the website.

Estimating the speed and direction of fire spread

Description: The device will determine the speed and direction of the fire spread by detecting the wind speed and direction using the wind vane and anemometer.

Air circulation for cooling and sampling

Description: The device will continuously pull in outside air into a chamber that houses the PCB, processor, and sensors. This allows the sensors to continuously sample the outside air for new signs of fire and acts as active cooling. The fan rpm will increase in reaction to increasing temperature.

5. Test Regulatory/Mandate Criteria

Not applicable

6. Test Pass/Fail Criteria

Photoelectric sensor - Pass: sensor senses smoke and combustion particles, photoelectric sensor flag is set to “activated”, which can be verified on the serial console and database. Fail: The photoelectric sensor does not detect smoke or combustion particles in the presence of them.

GPS Module - Pass: The GPS location is returned and verified on the serial console, as well as in the database. Fail: No location is returned, or garbage values are returned.

GSM Module - Pass: The GSM location is returned and verified on the serial console, as well as in the database. Fail: No location is returned, or garbage values are returned.

Query Debugging – Pass: Entering a command in the serial console to debug outputs sensor readings that are realistic and/or garbage. Fail: Entering a command in the serial console to debug outputs nothing.

User subscribing to push notifications - Pass: User receives confirmation text message. Fail: User doesn't.

User receiving push notifications - Pass: User receives text message. Fail: User doesn't.

Display Device(s) Data on Map (Home Page) - Pass: Device(s) Data are updated. Fail: Not Updated.

Display Device(s) Data on Admin Page – Pass: Device(s) Data are updated. Fail: Not Updated.

Display Sensor Issues on Admin Page – Pass: Device(s) Output Messages are updated. Fail: Not Updated.

Ionization Sensor – Pass: The ionization sensor will sense the smoke which will trigger a voltage change and display it on the Arduino console. It will also trigger the camera. Fail: The ionization sensor will maintain a constant voltage and the camera will not begin recording.

Camera – Pass: The camera will start video recording when the sensors alert it that there is smoke nearby. Fail: The camera will fail to record video if the sensors don't alert it.

Pushing sensor readings to the cloud – Pass: The device connects to the GSM network, connects to the MQTT broker, successfully sends the data to the database, and repeats the process after a set amount of time. Fail: The device fails to connect, the data loses integrity, or device can't consistently send new data.

Estimating the speed and direction of fire spread – Pass: The device senses the wind speed and direction with accuracy and precision. Fail: The device fails to detect the wind speed and direction with enough accuracy and precision.

Air circulation for cooling and sampling – Pass: Fan continuously pulls in air and the fan rpm reacts in direct variation to changing temperature. Fail: The fan fails to spin, or the fan rpm does not react in direct variation to changing temperature.

7. Test Entry/Exit Criteria

Photoelectric sensor - Begin testing when sensor is interfaced to microcontroller, and when code to detect the presence of smoke is written. Stop testing when 10 consecutive successful trials have occurred when exposing the sensor to smoke.

GPS Module - Begin testing when GPS module is interfaced to the microcontroller, and when code to output the location of the device is written. Stop testing when the location returned by the GPS module is verifiable and has been running for 5 minutes without any coordinate changes.

GSM Module - Begin testing when code to output the location using cell towers is written to the microcontroller. Stop testing when the location returned by the GSM module is verifiable and has been running for 5 minutes without any coordinate changes.

Query Debugging – Begin testing when debugging code for the microcontroller and sensors is written. Stop testing when command has been accepted and all sensors have been queried and have output their readings.

User subscribing to push notifications - Begin Testing when user creates an account, subscribes a phone number for updates. Stop testing when user receives a confirmation message.

User receiving push notifications – Begin Testing when user subscribes for push notifications and has a confirmation message and new device data is being pushed to the cloud. Stop testing when an alert is sent to subscribed users.

Display Device(s) Data on Map (Home Page) - Begin Testing when user/non-user loads the home page. Stop testing when new data is overwriting previous data on the map.

Display Device(s) Data on Admin Page – Begin Testing when troubleshooter loads the admin page. Stop testing when new data is overwriting previous data.

Display Sensor Issues on Admin Page – Begin Testing when troubleshooter loads the admin page. Stop testing when new output is overwriting previous output.

Ionization Sensor – Begin testing when the sensor is interfaced with the microcontroller and start testing with the code to detect smoke. Stop testing when 10 consecutive successful trials have occurred when the sensor is exposed to smoke.

Camera – Begin testing when the sensors trigger the camera and video recording will start. Stop testing after 5 consecutive successful trials have occurred where the sensors have triggered the camera.

Pushing sensor readings to the cloud – Begin when device powers on. Stop after the device has sent 5 consecutive payloads of sensor data or the device fails to connect/send data.

Estimating the speed and direction of fire spread – Begin when the device powers on and a fire is in the vicinity. Stop after 5 repetitions of the software.

Air circulation for cooling and sampling – Start when the device powers on. Stop after applying and removing heat to the temperature sensor and observing the sensor values / fan rpm.

8. Test Deliverables

Photoelectric sensor - A video demonstrating smoke driving the sensor will be provided. In the video, after the sensor is driven, output confirming that the photoelectric sensor engaged will be shown.

GPS Module – A video demonstrating the GPS module getting coordinates will be provided. The coordinates will be output on the serial console and will be verified by confirming them with my current location’s coordinates.

GSM Module - A video demonstrating the GSM module getting coordinates will be provided. The coordinates will be output on the serial console and will be verified by confirming them with my current location’s coordinates.

Query Debugging – A video demonstrating query debugging will be provided. In the video the troubleshooter will enter a command on the serial console, which will poll the sensors. The output will be the readings of the polled sensors.

User subscribing to push notifications - A video demonstrating a new user creating an account, navigating to the subscribe page and entering a valid phone number and receiving a confirmation message.

User receiving push notifications – A video demonstrating a subscribed user receiving an alert text message when the database detects new data and notices the alert value is 1 or 2.

Display Device(s) Data on Map (Home Page) - A video demonstrating a user/non-user loading the home page and viewing the data and watching the data being updated.

Display Device(s) Data on Admin Page – A video demonstrating a troubleshooter loading the admin page and viewing the data and watching the data being updated.

Display Sensor Issues on Admin Page – A video demonstrating a troubleshooter loading the admin page and viewing the sensor issue output and watching the output being updated.

Ionization Sensor – A video will be provided to show that the ionization sensor is detecting smoke. After the sensor detects the smoke, outputs confirming a voltage change will be shown for the ionization sensor.

Camera – A video will be provided to show that the camera is recording a video after the sensors trigger it. Once the video is taken, it will save it onto an SD card and send it over the cloud. Confirmation that it took a recording will be shown in the video.

Pushing sensor readings to the cloud – Screenshots of the sensor data as seen from the serial CLI with time stamps and the same data as seen from the database table with time stamps. Also, a short document comparing the values as the same timestamps.

Estimating the speed and direction of fire spread – Video of the wind vane and sensor reacting to the wind and displaying the wind direction and speed on the website.

Air circulation for cooling and sampling – Video of the fan powering up, reacting to changing temperature, and of the values from the temperature sensor on the serial CLI.

9. Test Suspension/Resumption Criteria

Photoelectric sensor - Suspend testing when the photoelectric sensor malfunctions due to extreme heat from the fire, or when it becomes a fire hazard. Resume testing when a functional photoelectric sensor is interfaced to the microcontroller and there is no fire hazard.

GPS Module – Suspend testing when no values or garbage values are output by the module. Resume testing when the code has been revised.

GSM Module –Suspend testing when no values or garbage values are output by the module. Resume testing when the code has been revised.

Query Debugging – Suspend testing when no values from the sensors are output when debugging command is given. Resume testing after code to poll sensors has been revised.

User subscribing to push notifications - Suspend testing when the new subscriber does not receive a response. Resume testing after code has been debugged and revised.

User receiving push notifications – Suspend testing when subscribers don't receive a response. Resume testing after code has been debugged and revised.

Display Device(s) Data on Map (Home Page) - Suspend testing when map doesn't showcase or update the device data. Resume testing after code has been debugged and revised.

Display Device(s) Data on Admin Page – Suspend testing when device data doesn't showcase or update. Resume testing after code has been debugged and revised.

Display Sensor Issues on Admin Page – Suspend testing when sensor issue output doesn't showcase or update. Resume testing after code has been debugged and revised.

Ionization Sensor – Suspend testing when the ionization sensor malfunctions due to extreme heat from the fire, or when it becomes a fire hazard. Resume testing when a functional ionization sensor is interfaced to the microcontroller and there is no fire hazard.

Camera – Suspend testing when the camera malfunctions due to extreme heat from the fire or when video recording fails. Resume testing when the camera cools down or has been reset to take video again.

Pushing sensor readings to the cloud – Suspend when the device can't make a connection to the GSM network. Resume when the device can make a connection.

Estimating the speed and direction of fire spread – Suspend when the wind vane/anemometer malfunctions. Resume when the malfunction is remedied.

Air circulation for cooling and sampling – Suspend when the fan fails to start spinning because of malfunction. Resume when the malfunction is remedied.

10. Test Environmental/Staffing/Training Needs (revise)

As for the environment, a grill or fireproof receptacle outdoors will be needed. This will contain the fire that will be the input to the device. A fire extinguisher is required when lighting a fire. To test the photoelectric sensor, ionization sensor, camera, GPS module, GSM Module and Query Debugging, a computer with the Arduino serial terminal will be needed. Knowledge of the Arduino serial console and how to navigate around it is necessary. Knowledge of fire safety is also required.

User receiving push notifications – Requires either a phone, tablet, or computer.

Display Device(s) Data on Map (Home Page) - Requires either a phone, tablet, or computer.

Display Device(s) Data on Admin Page – Requires either a phone, tablet, or computer.

Display Sensor Issues on Admin Page – Requires either a phone, tablet, or computer.

C. Non-Functional Testing

1. Test Risks/Issues

2. Items to be Tested/Not Tested

When testing the non-functional requirements of the device, what will mainly be used is inspection and verification. The power system will not be tested as it should operate as advertised, because it has been tested extensively.

Item to Test	Test Description	Test Date	Responsibility
PCB	Fix microcontroller, modules and sensors to the PCB. Power on the microcontroller, modules and sensors. Test the device assembled on the PCB by making sure all modules and sensors can communicate with the microcontroller. Verify the communication by monitoring the readings of modules and sensors on the serial port.		Luis Guevara
Enclosure	The enclosure will be modified to fit the items that will go inside. It will have openings to let air go through for the detection of a wildfire and for the camera.		Lluviana Vasquez
Insect Proof Mesh	In the enclosure, there will be insect mesh that will be fitted onto the openings of the box. This will prevent insects from entering the enclosure and damaging the items.		Lluviana Vasquez
Responsiveness of Website	Go to this website: https://codebeautify.org/responsive-website-tester and visually check if website is responsive to different devices		Edwin Hernandez
Device Indicator turns On/Off	Execute program, LED indicator will turn On, and when program ends, indicator turns Off.		Edwin Hernandez
Device Enclosure Color	Check with eyes that the device enclosure is green		Edwin Hernandez
Enclosure Size	Check if the size of the enclosure fits all the items needed.		Lluviana Vasquez
Device Weight	Check if the weight of the device is less than 1 Kg.		Matthew Wilson
Device Cost	Each unit should cost around $500 or less to build.		Matthew Wilson

3. Test Approach(s)

Most of the non-functional testing will be done with inspection and verification. The PCB will have all sensors and modules mounted, and then it will be verified if the sensors can communicate with the microcontroller seated on the PCB. The enclosure will need to be big enough for all the sensors and modules that are going to be inside of it and the color of it will need to be green, so it can blend with nature. It will also need insect proof mesh to avoid insects or debris big enough to go inside of it.

4. Test Cases

PCB

Description: The PCB will be made in accordance to the sensors and modules the device has. The sensors and modules will be seated on the PCB, and they will be the input to the microcontroller. The modules and sensors should communicate with the microcontroller.

Responsiveness of Website

Description: The website will be made to be responsive, meaning phones, tablets, and computers can view our website and have a user-friendly experience. The website will adjust its size based on the screen size.

Device Indicator turns On/Off

Description: The Device will showcase an LED on the box which defines if the device is on or off. We can verify by observing.

Device Enclosure Color

Description: The device enclosure will be green to blend in with the environment. We can verify by observing.

Enclosure

Description: The enclosure will need to meet the standard IP67. It will be made of plastic that has outstanding strength, stiffness, and its impact resistance. Since it will be outside, it will need to be weather resistant to protect the items that will be inside of it.

Insect Proof Mesh:

Description: The open parts of the enclosure will need to be covered in insect proof mesh to prevent insects and big enough debris from getting inside. This mesh will still allow smoke and air to pass through it.

Enclosure Size

Description: The size of the enclosure will need to be big enough for all of the items that will need to go inside of it.

Device Weight

Description: The weight of the unit will need to be less than 1 Kg.

Device Cost

Description: Each unit should cost around $500 or less to build.

5. Test Regulatory/Mandate Criteria

Not applicable

6. Test Pass/Fail Criteria

PCB – Pass: seated components and modules can communicate with the microcontroller. Fail: seated components and modules cannot communicate with the microcontroller.

Responsiveness of Website - Pass: Website is multi-device compatible. Fail: Website is not multi-device compatible.

Device Indicator turns On/Off - Pass: Indicator matches device state. Fail: Device indicator doesn't match device state.

Device Enclosure Color – Pass: Enclosure is green. Fail: Enclosure isn't green.

Enclosure – Pass: The enclosure will need to meet the standard IP67 and be weatherproof. Fail: The enclosure fails to meet the standard IP67 and is not weatherproof.

Insect Proof Mesh – Pass: The insect proof mesh will be needed to prevent insects and big enough debris from entering the enclosure. It will also need to allow smoke and air to pass through. Fail: The insect proof mesh fails to prevent insects and big enough debris from entering the enclosure and does not allow smoke and air to pass through.

Enclosure size – Pass: The size of the enclosure will fit all required components that are needed to be inside. Fail: The size of the enclosure does not fit all required components.

Device Weight – Pass: The weight of one unit is less than 1 Kg. Fail: The unit weight exceeds 1 Kg.

Device Cost – Pass: The cost of one unit is less than $550. Fail: The cost of one unit exceeds $550.

7. Test Entry/Exit Criteria

PCB – Begin testing when all modules and sensors are seated on the PCB. Stop testing once communication from all sensors and modules to the microcontroller is established.

Responsiveness of Website – Begin Testing when the website loads. Stop Testing when the website crashes.

Device Indicator turns On/Off - Begin Testing when the device program starts. Stop testing when the device stops.

Device Enclosure Color – Begin testing when user is observing the enclosure. Stop testing when the device is fully observed.

Enclosure – Begin testing by checking the standard on the enclosure and seeing if it's weatherproofed by simulating a weather change. Stop testing when the enclosure meets standard and weatherproof tests.

Insect Proof Mesh – Begin testing by checking if big enough debris and insects are prevented from entering the enclosure, and if smoke and air are allowed through it. Stop testing when the insect proof mesh has prevented insects and big enough debris and has allowed smoke and air to pass through it.

Enclosure size – Begin testing by checking if all components fit inside the enclosure. Stop testing when the enclosure meets the required size for all components to fit.

Device Weight – Begin testing by placing the finished unit on a scale. Stop testing after observing and recording the weight.

Device Cost – Begin testing after integrating all the components and calculate the total price. Stop testing after calculating the total price of the unit.

8. Test Deliverables

PCB – A video showing sensors and modules seated on the PCB will be provided. In the video, communication between the modules/sensors and the microcontroller will be shown through outputs in the Arduino serial terminal.

Responsiveness of Website – A video demonstrating the responsiveness of the website. In the video, I will use this website to show you different device formats and what they look like.

Device Indicator turns On/Off - A video demonstrating the device turning on/off when the device is running/not-running.

Device Enclosure Color – A image demonstrating the enclosure is green.

Enclosure – The enclosure will need to meet the standard IP67, and a video will be provided to demonstrate that it is weather and impact resistant.

Insect Proof Mesh – A video demonstrating that the insect proof mesh does not allow insects and debris from going inside the enclosure.

Enclosure size – An image will be taken of the inside and outside of the enclosure to see if all of the components fit without it being cluttered.

Device Weight – An image of the device on a scale and the weight.

Device Cost – A document detailing each component, their individual prices, and the total combined cost.

9. Test Suspension/Resumption Criteria

PCB – Suspend testing when garbage values are output by the modules/sensors or when no communication is established between the modules/sensors within 3 minutes.

Responsiveness of Website – Suspend testing when website isn't adjusting based on screen size. Resume testing after code has been debugged and revised.

Device Indicator turns On/Off - Suspend testing when indicator doesn't change state based on program running/stopping. Resume testing after code has been debugged and revised.

Device Enclosure Color – Suspend testing when enclosure is not green. Resume testing when enclosure is green.

Enclosure – Suspend testing if the enclosure does not meet the standard IP67, is not weatherproof, and it is not impact resistant. Resume testing when the enclosure meets the standard IP67, it is weatherproof, and its impact resistant.

Insect Proof Mesh – Suspend testing if the insect proof mesh fails to stop insects and big enough debris from going inside the enclosure. Resume testing when the insect proof mesh stops insects and big enough debris from entering the enclosure.

Enclosure size – Suspend testing if the size of the enclosure is too small and the components are cluttered inside. Resume testing when the size of the enclosure fits all required components without clutter.

Device Weight – Suspend testing if the scale fails. Resume when an operable scale is available.

Device Cost – Testing shouldn't be suspended.

10. Test Environmental/Staffing/Training Needs

A computer with the Arduino serial terminal will be required. Simple circuit knowledge will be necessary to test the PCB.

A scale large enough for the device is required. Knowledge of operating a scale is needed.

D. Regression Testing

1. Test Risks/Issues

Besides the risks outlined in the functional and non-functional testing, there is no other physical risk in regression testing. However, there is a risk of the sensors/modules malfunctioning as we include and modify library code that interface sensors/provide functions. Some possible risks include modules and sensors not communicating with the microcontroller. When we make changes to our code, it is important to re-test every piece of code that we did not change, to ensure everything is operating well.

2. Items to be Tested/Not Tested

Item to Test	Test Description	Test Date	Responsibility
Photoelectric sensor library code	The photoelectric sensor will be interfaced to the microcontroller. It will be placed next to a burning fire. The photoelectric sensor should detect the presence of smoke, which will be verified on the serial console on a computer.		Luis Guevara

GPS module library code	The GPS module will be interfaced to the microcontroller. The GPS module will be outside, and should return the location coordinates, which will be verified on the serial console on a computer.		Luis Guevara
GSM module library code	The GSM module is already interfaced with the microcontroller. It will be outside, and should return the location coordinates, which will be verified on the serial console on a computer.		Luis Guevara
Ionization sensor library code	The ionization sensor will be interfaced to the microcontroller. It will be placed next to a burning fire, and it should detect the presence of smoke. This will be verified on the serial console on a computer.		Lluviana Vasquez
Camera library code	The camera will be interfaced to the controller. The camera will remain inside, but it will need to be facing outside. It should send video to the cloud when smoke is detected by the sensors.		Lluviana Vasquez
Subscribe push notification library code	The API will be interfaced with the website which is called when the user has entered their phone number and clicked submit		Edwin Hernandez
Push notification library code	The lambda function will be interfaced with the database that executes when new data is being stored.		Edwin Hernandez
Fetch device data library code	The API will be interfaced with the website which is called when the home/admin page is loaded		Edwin Hernandez
GSM to Cloud code	The GSM module will be interfaced with the microcontroller and antenna and be placed outside. It will return the sensor values which will be verified on the serial console.		Matthew Wilson
Temp/Humi code	The temp/humi sensor is interfaced with the processor and GSM module and placed outside. The device will notify command control if the temp reaches 58 degrees C.		Matthew Wilson
Cooling Fan Code	The fan is interfaced with the processor and temp/humi sensor. The fan will spin on power up and change rpm in direct correlation with the outside temp.		Matthew Wilson
Wind Sensors code	The wind vane and anemometer are interfaced with the processor and placed		Matthew Wilson

	outside. The sensors will return the wind speed and direction.		

3. Test Approach(s)

Individual components have been assumed to be tested and verified. At this stage of the development cycle, we as a team begin to integrate all separate parts together, which will hopefully interface with each other seamlessly. With integration, we will change some of the code, but not all. For regression testing, we want to test again everything that was not changed, to make sure unchanged devices or code are still operating as they were before the integration. In our case, it will include re-testing code that was used to interface the modules/sensors again.

4. Test Cases

Photoelectric sensor code

Description: The photoelectric sensor will be exposed to smoke. The presence of smoke is the input that will drive the sensor. When the sensor activates, it will set a flag in the code that will be sent to the database over cellemetry, indicating that the photoelectric sensor has been triggered.

GPS Module code

Description: The GPS module will be outdoors, tracking the location of the device using satellites. These satellites will provide the input to the GPS module. The GPS module and microprocessor will translate the inputs into readable coordinates, which will then be pushed to the database over cellemetry.

GSM Module code

Description: The GSM module will be outdoors, tracking the location of the device using cell towers. These cell towers will provide the input to the GSM module. The GSM module and microprocessor will translate the inputs into readable coordinates, which will then be pushed to the database over cellemetry.

Ionization sensor code

Description: The ionization sensor will be exposed to smoke. The presence of smoke is the input that will drive the sensor. When the sensor activates, it will set a flag in the code that will be sent to the databased over cellemetry. This will indicate that the ionization sensor has been triggered.

Camera code:

Description: The camera will be triggered by the sensors. It will remain inside the enclosure, but the enclosure will need a hole where the lens will be placed at. It will record a video to display that there is a wildfire nearby. This video will then be sent to the cloud and will be pushed to the database over cellemetry.

Subscribe push notification code:

Description: The API handling the push notification to the users phone number will be called when the user submits their phone number to be subscribed. This will then store the user's id and phone number to a separate database and last send a confirmation message.

Push notification code:

Description: The lambda function is connected to the database as a trigger event. Which listens for new data being stored and determines from that data is there a potential fire/fire based on the alert value. From there, if identified, a message will be sent to all subscribed users.

Fetch device data code:

Description: The API handles fetching the most recent device data which will be displayed on the website once completed.

GSM to Cloud code:

Description: The device will send device data and data from the sensors to the database.

Temp/Humi code:

Description: The sensor will return the temp and humidity to the processor.

Cooling Fan code:

Description: The fan rpm should change in direct correlation to the temperature.

Wind Sensor code:

Description: The sensors should return the wind speed and direction.

5. Test Regulatory/Mandate Criteria

Not applicable

6. Test Pass/Fail Criteria

Photoelectric sensor - Pass: sensor senses smoke and combustion particles, photoelectric sensor flag is set to "activated", which can be verified on the serial console and database. Fail: The photoelectric sensor does not detect smoke or combustion particles in the presence of them.

GPS Module - Pass: The GPS location is returned and verified on the serial console, as well as in the database. Fail: No location is returned or garbage values are returned.

GSM Module - Pass: The GSM location is returned and verified on the serial console, as well as in the database. Fail: No location is returned or garbage values are returned.

Ionization sensor – Pass: The sensor senses smoke and the ionization sensor will jump in voltage which can be verified on the serial console and database. Fail: The ionization sensor does not detect smoke and does not alert when there is wildfire present.

Camera – Pass: The camera will be triggered by the sensors and will begin recording video of the wildfire. Once recorded, it will send it to the cloud over cellemetry. Fail: The camera does not

get triggered by the sensors and fails to record a video of the wildfire. It does not send data to the cloud.

Subscribe push notification code – Pass: Sends user confirmation message. Fail: Doesn't receive message

Push notification code - Pass: subscribers receive alert message. Fail: Doesn't receive message

Fetch device data code - Pass: Data is fetched. Fail: Data isn't fetched.

GSM to Cloud code – Pass: Sensor data is transmitted successfully. Fail: Sensor data is not transmitted.

Temp/Humi code – Pass: Temperature and humidity are detected and accurate. Fail: Temp or humi are not detected.

Cooling Fan code – Pass: Fan changes rpm with temperature. Fail: Fan does not power on or change rpm with temperature.

Wind Sensors code – Pass: Sensors return the wind speed and direction. Fail: Sensors do not return wind speed or direction.

7. Test Entry/Exit Criteria

Photoelectric sensor - Begin testing when sensor is interfaced to microcontroller, and when code to detect the presence of smoke is written. Stop testing when 10 consecutive successful trials have occurred when exposing the sensor to smoke.

GPS Module - Begin testing when GPS module is interfaced to the microcontroller, and when code to output the location of the device is written. Stop testing when the location returned by the GPS module is verifiable.

GSM Module - Begin testing when code to output the location using cell towers is written to the microcontroller. Stop testing when the location returned by the GSM module is verifiable.

Ionization Sensor – Begin testing when the sensor is interfaced with the microcontroller and start testing with the code to detect smoke. Stop testing when 10 consecutive successful trials have occurred when the sensor is exposed to smoke.

Camera – Begin testing when the sensors trigger the camera and video recording will start. Stop testing after 5 consecutive successful trials have occurred where the sensors have triggered the camera.

Subscribe push notification code – Begin testing when user enter phone number. Stop testing when user receives message.

Push notification code – Begin testing when new data with alert value is 1 or 2. Stop testing when subscribers received message.

Fetch device data code - Begin testing when page is loading. Stop testing when page loads data.

GSM to Cloud code – Begin testing when the device powers on. Stop when the device transmits 5 payloads of data.

Temp/Humi code – Begin testing when the device is on and taken outside. Stop when the device returns the sensor values 5 times.

Cooling Fan code – Begin testing when the device powers on. Stop after measuring the fan rpm and sensor temp.

Wind Sensors code – Begin testing when the device is on, outside, and wind is present. Stop after the device returns the sensor values 5 times.

8. Test Deliverables

Photoelectric sensor - A video demonstrating smoke driving the sensor will be provided. In the video, after the sensor is driven, output confirming that the photoelectric sensor engaged will be shown.

GPS Module – A video demonstrating the GPS module getting coordinates will be provided. The coordinates will be output on the serial console, and will be verified by confirming them with my current location's coordinates.

GSM Module - A video demonstrating the GSM module getting coordinates will be provided. The coordinates will be output on the serial console and will be verified by confirming them with my current location's coordinates.

Ionization Sensor – A video will be provided to show that the ionization sensor is detecting smoke. After the sensor detects the smoke, outputs confirming a voltage change will be shown for the ionization sensor.

Camera – A video will be provided to show that the camera is recording a video after the sensors trigger it. Once the video is taken, it will save it onto an SD card and send it over the cloud. Confirmation that it took a recording will be shown in the video.

Subscribe push notification code – A video demonstrating a new user creating an account, navigating to the subscribe page and entering a valid phone number and receiving a confirmation message.

Push notification code – A video demonstrating a subscribed user receiving an alert text message when the database detects new data and notices the alert value is 1 or 2.

Fetch device data code - A video demonstrating a user/non-user loading the home page and viewing the data and watching the data being updated.

GSM to Cloud code – A video demonstrating the serial monitor and website updating with new values.

Temp/Humi code – Video of the temperature and humidity sensor values on the serial console.

Cooling Fan code – Video showing the fan turning on and changing speed in reaction to heat.

Wind Sensors code – Video of the sensors reacting to the wind and returning the sensor values.

9. Test Suspension/Resumption Criteria

Photoelectric sensor - Suspend testing when the photoelectric sensor malfunctions due to extreme heat from the fire, or when it becomes a fire hazard. Resume testing when a functional photoelectric sensor is interfaced to the microcontroller and there is no fire hazard.

GPS Module – Suspend testing when no values or garbage values are output by the module. Resume testing when code has been revised.

GSM Module –Suspend testing when no values or garbage values are output by the module. Resume testing when the code has been revised.

Ionization Sensor – Suspend testing when the ionization sensor malfunctions due to extreme heat from the fire, or when it becomes a fire hazard. Resume testing when a functional ionization sensor is interfaced to the microcontroller and there is no fire hazard.

Camera – Suspend testing when the camera malfunctions due to extreme heat from the fire or when video recording fails. Resume testing when the camera cools down or has been reset to take video again.

Subscribe push notification code – Suspend testing when the new subscriber does not receive a response. Resume testing after code has been debugged and revised.

Push notification code – Suspend testing when subscribers don't receive a response. Resume testing after code has been debugged and revised.

Fetch device data code - Suspend testing when map doesn't showcase or update the device data. Resume testing after code has been debugged and revised.

GSM to Cloud code – Suspend when a connection can't be made. Resume when a connection is made.

Temp/Humi code – Suspend when the heat could damage the device. Resume when temp is safe for the device.

Cooling Fan code – Suspend when the fan fails to turn on. Resume when the issue is fixed.

Wind Sensors code – Suspend when there is no wind and wind cannot be created. Resume when the wind is present.

10. Test Environmental/Staffing/Training Needs

As for the environment, a grill or fireproof receptacle outdoors will be needed. This will contain the fire that will be the input to the device. A fire extinguisher is required when lighting a fire. To test the photoelectric sensor code, the ionization sensor code, camera, GPS module code and GSM Module code, a computer with the Arduino serial terminal will be needed. Knowledge of the Arduino serial console and how to navigate around it is necessary. Knowledge of fire safety is also required.

E. Performance Testing

1. Test Risks/Issues

There are no new added physical risks while testing for performance, besides the fire hazards highlighted earlier.

2. Items to be Tested/Not Tested

Item to Test	Test Description	Test Date	Responsibility
Ionization/Photoelectric Sensors	The sensors will be exposed to a fire. Time will be measured from when the fire started to when the sensors sensed the smoke.		Luis Guevara/ Lluviana Vazquez
GPS Module	The device will be plugged into a computer with the Arduino serial console. The device will be turned on, and a timer will start. Timer will stop whenever valid GPS coordinates are displayed on the serial console.		Luis Guevara
GSM Module	The device will be plugged into a computer with the Arduino serial console. The device will be turned on, and a timer will start. Timer will stop whenever valid coordinates and sensor data attained by the GSM module are displayed on the serial console		Luis Guevara/ Matthew Wilson
Camera	The device will be connected to the microcontroller and will only turn on when the sensors are exposed to smoke. It will record a video and send this video to the cloud, so the user can see the potential fire that has started.		Lluviana Vasquez
Home/Admin page – Website	The website will be fetching and updating every 60 seconds.		Edwin Hernandez
Push Notifications	The push notifications will be sent immediately when an alert is noticed		Edwin Hernandez
Temp/Humi Sensor	The sensor will be exposed to heat. The sensor values will be recorded for 5 cycles.		Matthew Wilson
Cooling fan	The temperature of the processor will be recorded as the device is exposed to fire.		Matthew Wilson
Wind Sensors	The wind speed and direction returned from the sensors will be		Matthew Wilson

	compared to the actual wind speed and direction.		

3. Test Approach(s)

In this section of testing, we are testing the responsiveness of our device, as it is a real time system. We will expose the device to a controlled fire and measure the time it takes from when a fire begins to when the fire triggers the device's sensors. We will then measure the time it takes for the device triggers to be sent over cellemetry to the database. We will also test how responsive the GPS and GSM devices are, and we'll measure the time it takes from powering the device to finding its' location using both GSM and GPS modules. The camera will also be tested to see if the video has successfully been sent through the cloud when the sensors trigger it to start recording for a potential wildfire.

4. Test Cases

Ionization/Photoelectric Sensors

Description: The device will be connected to a computer with the Arduino serial console open. The sensors will be exposed to smoke from a controlled fire, which will be the input to the sensors. Time will be measured from when the fire has visible smoke, to when the sensors detect the smoke. Time will also be measured from when the fire was detected to the sensors to when the data arrives in the database.

GPS Module

Description: The device will be connected to a computer with the Arduino serial console open. A timer will be started from when the device is turned on. The GPS module will then retrieve the location coordinates and display them on the console. The timer will stop when valid coordinates are output.

GSM Module

Description: The device will be connected to a computer with the Arduino serial console open. A timer will be started from when the device is turned on. The GSM module will then retrieve the location coordinates and sensor data and display them on the console. The timer will stop when valid coordinates are output.

Camera

Description: The device will be connected to the microcontroller and with the Arduino serial console open. When the sensors are exposed to smoke, it will trigger the camera to turn on. The camera will then start recording a video of the potential wildfire and save it into the SD card. Once it is saved, it will begin the process to send it through the cloud so it can be viewable to the user. We will time this to see how long it takes to send.

Home/Admin page – Website

Description: When a user/non-user loads the home page or when a troubleshooter loads the admin page, device data will be fetched and displayed on the map or as data respectively, which will be updated every 60 seconds.

Push Notifications

Description: To receive push notifications, the user must have an account and subscribe by navigating to the subscribe page, entering their phone number, and submitting it. Once submitted, a confirmation text message will be sent to the user and the database will be updated with the new data. When new device data is pushed to the database, a lambda function will check the associated alert value, and if it is 1 or 2, it will send a text message to all subscribers who have subscribed to push notifications.

Temp/Humi code:

Description: The sensor will return the temp and humidity to the processor.

Cooling Fan code:

Description: The fan rpm should change in direct correlation to the temperature. The relationship of the fan frequency and temperature can be described with this equation: Fan Frequency = 3.82(temperature in C) – 27.68 for temperature = [24, 75].

Wind Sensor code:

Description: The sensors should return the accurate and precise wind speed and direction.

5. Test Regulatory/Mandate Criteria

Not applicable

6. Test Pass/Fail Criteria

Photoelectric/Ionization sensors - Pass: sensors sense smoke and combustion particles, sensor flags are set to “activated” within 2 minutes. Fail: sensors sense nothing in the presence of smoke, or it takes the sensors over 2 minutes to sense smoke.

GPS Module - Pass: The GPS location is returned and verified on the serial console, taking no more than 2 minutes. Fail: No location is returned, or location is returned after 2 minutes.

GSM Module - Pass: The GSM location and sensor data are returned and verified on the serial console, taking no more than 10 minutes. Fail: No location or sensor data is returned or is returned after 10 minutes.

Camera – Pass: The camera manages to turn on only when there is a fire detected, video is recorded, and it is sent through the cloud within 5 minutes. Fail: The camera does not turn on where fire is detected, video fails to record, and it is not sent to the cloud after 5 minutes.

Temp/Humi code – Pass: Temperature and humidity are detected and accurate. Fail: Temp or humi are not detected.

Cooling Fan code – Pass: Fan changes rpm with temperature. Fail: Fan does not power on or change rpm with temperature.

Wind Sensors code – Pass: Sensors return the wind speed and direction. Fail: Sensors do not return wind speed or direction.

7. Test Entry/Exit Criteria

Photoelectric/Ionization sensors - Begin testing when fire is created. Stop testing when 10 consecutive successful trials have occurred when exposing the sensor to smoke.

GPS Module - Begin testing when the device is turned on. Stop testing when the location returned by the GPS module is verifiable and has been running for 5 minutes without any coordinate changes.

GSM Module - Begin testing when the device is turned on. Stop testing when the data returned by the GSM module is verifiable and has been running for 10 minutes without any anomalies.

Camera – Begin testing when the camera is turned on by the sensors, starts video recording, and sends it through the cloud. Stop testing when the camera has successfully saved and sent the video through the cloud.

Home/Admin page - Begin testing when page is loading. Stop testing when new data is overwriting previous data of the devices.

Push Notifications - Begin testing when an action regarding an alert or subscribering is executed. Stop testing when user receives text message.

Temp/Humi code – Begin testing when the device is on and taken outside. Stop when the device returns the sensor values 5 times.

Cooling Fan code – Begin testing when the device powers on. Stop after measuring the fan rpm and sensor temp.

Wind Sensors code – Begin testing when the device is on, outside, and wind is present. Stop after the device returns the sensor values 5 times.

8. Test Deliverables

Photoelectric/Ionization sensor - A video demonstrating a timer turning on while a fire has started will be provided. In the video, the sensors will be exposed to the smoke. After the sensors are driven, output confirming that the photoelectric sensor engaged will be shown. The timer will stop and time elapsed will be shown.

GPS Module – A video demonstrating a timer turning on while turning on the device will be provided. The GPS module will then get the location coordinates. The coordinates will be output on the serial console, and will be verified by confirming them with my current location’s

coordinates. The timer will stop once verifiable coordinates are output, and the elapsed time will be shown.

GSM Module - A video demonstrating a timer turning on while turning on the device will be provided. The GSM module will then get the data. The data will be output on the serial console and will be verified by confirming them with my current location's coordinates and weather details. The timer will stop once verifiable data is output, and the elapsed time will be shown.

Camera – A video demonstrating that the camera will turn on only when the sensors detect that a wildfire is nearby. A timer will start when the camera starts recording a video, it will save it onto an SD card and then send it over the cloud. After this, confirmation will be shown. The timer will stop and time elapsed will be shown.

Home/Admin page - A video demonstrating the page loads and having a timer showcasing the time passing and data being updated.

Push Notifications – A video demonstrating the user receiving a message when one of the actions are executed.

Temp/Humi code – Video of the temperature and humidity sensor values on the serial console.

Cooling Fan code – Video showing the fan turning on and changing speed in reaction to heat.

Wind Sensors code – Video of the sensors reacting to the wind and returning the sensor values.

9. Test Suspension/Resumption Criteria

Photoelectric/Ionization sensors - Suspend testing when the sensors malfunction due to extreme heat from the fire, or when it becomes a fire hazard. Resume testing when functional photoelectric/ionization sensor is interfaced to the microcontroller and there is no fire hazard.

GPS Module – Suspend testing when no values or garbage values are output by the module, or when the device has been operating for 2 minutes with no output. Resume testing when code has been revised.

GSM Module – Suspend testing when no values or garbage values are output by the module, or when the device has been operating for 2 minutes with no output. Resume testing when code has been revised.

Camera – Suspend testing when the camera does not turn on when the sensors detect that a wildfire is nearby. Resume testing when the camera is detected.

Home/Admin page – Suspend testing when device data doesn't showcase or update on time. Resume testing after code has been debugged and revised.

Push Notifications – Suspend testing when user doesn't receive a message. Resume testing after code has been debugged and revised.

Temp/Humi code – Suspend when the heat could damage the device. Resume when temp is safe for the device.

Cooling Fan code – Suspend when the fan fails to turn on. Resume when the issue is fixed.

Wind Sensors code – Suspend when there is no wind and wind cannot be created. Resume when the wind is present.

10. Test Environmental/Staffing/Training Needs

As for the environment, a grill or fireproof receptacle outdoors will be needed. This will contain the fire that will be the input to the device. A fire extinguisher is required when lighting a fire. To test the performance of photoelectric/ionization sensors, camera, GPS module and GSM Module, a computer with the Arduino serial terminal will be needed. A timer will also be needed to keep time. Knowledge of the Arduino serial console and how to navigate around it is necessary. Knowledge of fire safety is also required.

F. Unit Testing

1. Test Risks/Issues

When unit testing, there is risk of a sensor or module malfunctioning. Each unit is being tested individually, and some error or malfunction may occur when testing.

2. Items to be Tested/Not Tested

Item to Test	Test Description	Test Date	Responsibility
Photoelectric sensor modified code	The photoelectric sensor will be interfaced to the microcontroller. It will be placed next to a burning fire. The photoelectric sensor should detect the presence of smoke, which will be verified on the serial console on a computer.		Luis Guevara
GPS module modified code	The GPS module will be interfaced to the microcontroller. The GPS module will be outside, and should return the location coordinates, which will be verified on the serial console on a computer.		Luis Guevara
GSM module modified code	The GSM module is already interfaced with the microcontroller. It will be outside, and should return the location coordinates and sensor data, which will be verified on the serial console on a computer.		Luis Guevara/ Matthew Wilson

Connecting AWS Services to Website	The Services will relate to the application by using a package by AWS called, AWS Amplify. This allows to interact with many features		Edwin Hernandez
Ionization sensor modified code	The ionization sensor will be interfaced to the microcontroller, and it be placed next to a burning fire. The ionization sensor should detect the presence of smoke and it will send confirmation on the serial console on the computer.		Lluviana Vasquez
Camera modified code	The camera will be interfaced on the microcontroller. It will switch on when the sensors alert it that there is a fire nearby. Once switched on, it will start recording a video and save it on an SD card. It will then send this video to the cloud.		Lluviana Vasquez
Temp/Humi Sensor	The sensor will be exposed to heat. The sensor values will be recorded for 5 cycles.		Matthew Wilson
Cooling fan	The temperature of the processor will be recorded as the device is exposed to fire.		Matthew Wilson
Wind Sensors	The wind speed and direction returned from the sensors will be compared to the actual wind speed and direction.		Matthew Wilson

3. Test Approach(s)

Every unit of code, whether it is code to interface a sensor or module, or code that establishes communication between the microcontroller and database will be tested. Sensors/modules will be exposed to a controlled fire, to trigger the functionality of the modules/sensors. All units will be verified that they're in working order before attempting integration.

4. Test Cases

Photoelectric sensor modified code

Description: The code will be uploaded to the microcontroller. The photoelectric sensor will be exposed to smoke. The presence of smoke is the input that will drive the sensor. When the sensor activates, it will set a flag in the code that will be sent to the database over cellemetry, indicating that the photoelectric sensor has been triggered.

GPS Module modified code

Description: The code will be uploaded to the microcontroller. The GPS module will be outdoors, tracking the location of the device using satellites. These satellites will provide the input to the GPS module. The GPS module and microprocessor will translate the inputs into readable coordinates, which will then be pushed to the database over cellemetry.

GSM Module modified code

Description: The code will be uploaded to the microcontroller. The GSM module will be outdoors, tracking the location of the device using cell towers. The module will also get sensor data. These cell towers and sensor data will provide the input to the GSM module. The GSM module and microprocessor will translate the inputs into readable coordinates, which will then be pushed to the database over cellemetry.

Connecting AWS Services to Website

Description: The package will be installed as a node module using npm. The package installed is called AWS Amplify which allows you to configure and interact with many AWS services. We use this package to pull data from specific databases, create APIs, and lambda functions.

Ionization sensor modified code

Description: The code will be uploaded to the microcontroller. The ionization sensor will be exposed to smoke and it will be the input that will drive the sensor. When the sensor activates, it will set a flag in the code, and this will be sent to the database over cellemetry indicating that the sensor has been triggered.

Camera modified code

Description: The code will be uploaded to the microcontroller. The camera will turn on when the sensors indicate that there is a fire nearby and start recording a video. This video will be saved onto the SD card and sent over to the cloud.

Temp/Humi code:

Description: The sensor will return the temp and humidity to the processor.

Cooling Fan code:

Description: The fan rpm should change in direct correlation to the temperature. The relationship of the fan frequency and temperature can be described with this equation: Fan Frequency = 3.82(temperature in C) – 27.68 for temperature = [24, 75].

Wind Sensor code:

Description: The sensors should return the accurate and precise wind speed and direction.

5. Test Regulatory/Mandate Criteria

Not applicable

6. Test Pass/Fail Criteria

Photoelectric sensor - Pass: sensor senses smoke and combustion particles, code sets sensor flag to “activated” within 2 minutes. Fail: sensor code senses nothing in the presence of smoke.

GPS Module - Pass: Code returns the GPS location, verified on the serial console. Fail: No location is returned or garbage location is returned.

GSM Module - Pass: Code returns the GSM location and sensor data, verified on the serial console. Fail: No location or data is returned, or garbage data is returned.

Connecting AWS Services to Website – Pass: Can pull data from the database. Fail: Can’t pull data from the database

Ionization sensor – Pass: The sensor senses smoke and the voltage increase within 2 minutes. Fail: The sensor code does not sense smoke.

Camera – Pass: The code turns on the camera, records a video and saves it, and sends it to the cloud. Fail: The code does not turn on the camera, record a video/save it, and send it to the cloud.

Temp/Humi code – Pass: Temperature and humidity are detected and accurate. Fail: Temp or humi are not detected.

Cooling Fan code – Pass: Fan changes rpm with temperature. Fail: Fan does not power on or change rpm with temperature.

Wind Sensors code – Pass: Sensors return the wind speed and direction. Fail: Sensors do not return wind speed or direction.

7. Test Entry/Exit Criteria

Photoelectric sensor - Begin testing when sensor is interfaced to microcontroller, and when code to detect the presence of smoke is written. Stop testing when 10 consecutive successful trials have occurred when exposing the sensor to smoke.

GPS Module - Begin testing when GPS module is interfaced to the microcontroller, and when code to output the location of the device is written. Stop testing when the location returned by the GPS module is verifiable.

GSM Module - Begin testing when code to output the data using cell towers and sensors is written to the microcontroller. Stop testing when the data returned by the GSM module is verifiable.

Connecting AWS Services to Website – Begin testing when accessing the website. Stop testing when the data is shown on the website.

Ionization sensor – Begin testing when the sensor is interfaced to microcontroller and once the code to detect smoke is written. Stop testing when 10 consecutive successful trials have occurred when exposing the sensor to smoke.

Camera – Begin testing when the camera is interfaced to the microcontroller and when the code begins detecting the camera and its functions work. Stop testing when the code recognizes the camera and its functions.

Temp/Humi code – Begin testing when the device is on and taken outside. Stop when the device returns the sensor values 5 times.

Cooling Fan code – Begin testing when the device powers on. Stop after measuring the fan rpm and sensor temp.

Wind Sensors code – Begin testing when the device is on, outside, and wind is present. Stop after the device returns the sensor values 5 times.

8. Test Deliverables

Photoelectric sensor - A video demonstrating smoke driving the sensor will be provided. In the video, after the sensor is driven, output confirming that the photoelectric sensor engaged will be shown. This will verify that the modified code is functional.

GPS Module – A video demonstrating the GPS module getting coordinates will be provided. The coordinates will be output on the serial console and will be verified by confirming them with my current location's coordinates. This will verify that the modified code is functional.

GSM Module - A video demonstrating the GSM module getting data will be provided. The data will be output on the serial console and will be verified by confirming them with my current location's coordinates and weather. This will verify that the modified code is functional.

Connecting AWS Services to Website – A video demonstrating the website can use AWS services.

Ionization sensor – A video demonstrating smoke driving the sensor will be provided. In the video, after the sensor is driven, output confirming that the ionization sensor is engaged will be shown. This will verify that the modified code is functional.

Camera – A video demonstrating that the camera is detected with all its functions will be provided. In the video, after it has turned on due to the sensors alerting it of the presence of smoke, it will be verified that it has taken video on the SD card. Once verified, it will send it through the cloud. This will be the confirmation that the code is functional.

Temp/Humi code – Video of the temperature and humidity sensor values on the serial console.

Cooling Fan code – Video showing the fan turning on and changing speed in reaction to heat.

Wind Sensors code – Video of the sensors reacting to the wind and returning the sensor values.

9. Test Suspension/Resumption Criteria

Photoelectric sensor - Suspend testing when the sensor malfunctions due to extreme heat from the fire, or when it becomes a fire hazard. Resume testing when a functional photoelectric sensor is interfaced to the microcontroller and there is no fire hazard.

GPS Module – Suspend testing when no values or garbage values are output by the module. Resume testing when the code has been revised.

GSM Module – Suspend testing when no values or garbage values are output by the module. Resume testing when the code has been revised.

Connecting AWS Services to Website – Suspend testing when the website isn't loading. Resume testing when the code has been revised.

Ionization sensor – Suspend testing when the sensor malfunctions due to extreme heat from the fire, or when it becomes a fire hazard. Resume testing when a functional ionization sensor is interfaced to the microcontroller and there is no fire hazard.

Camera – Suspend testing when the camera is not detected, and it is not recording video. Resume testing when the code has been revised.

Temp/Humi code – Suspend when the heat could damage the device. Resume when temp is safe for the device.

Cooling Fan code – Suspend when the fan fails to turn on. Resume when the issue is fixed.

Wind Sensors code – Suspend when there is no wind and wind cannot be created. Resume when the wind is present.

10. Test Environmental/Staffing/Training Needs

As for the environment, a grill or fireproof receptacle outdoors will be needed. This will contain the fire that will be the input to the device. A fire extinguisher is required when lighting a fire. To test the photoelectric sensor, ionization sensor, camera, GPS module, GSM Module and Query Debugging, a computer with the Arduino serial terminal will be needed. Knowledge of the Arduino serial console and how to navigate around it is necessary. Knowledge of fire safety is also required.

G. Integration Testing

1. Test Risks/Issues

There will be no added physical risks when integration testing. The only risks posed when integrating are components and modules malfunctioning due to them being connected into subsystems and eventually one main system.

2. Items to be Tested/Not Tested

Item to Test	Test Description	Test Date	Responsibility
Fire Detection subsystem	The fire detection consists of both Ionization/Photoelectric sensors, as well as a temperature and humidity sensor. All these components will be interfaced to the microcontroller. It will then be placed next to a burning fire. The fire detection subsystem should detect the presence of smoke, which will be verified on the serial console on a computer.		Luis Guevara/Lluviana Vazquez/Matthew Wilson
Location subsystem	The location subsystem consists of the GPS and GSM modules. Both of these components will be interfaced to the microcontroller. The device will be outside, then turned on. It should return the location coordinates, which will be verified on the serial console on a computer.		Luis Guevara
Query Debugging subsystem	This subsystem is a compilation of various functions that poll all of the components interfaced to the microcontroller. A command will be entered to the serial console while the device is connected to a computer. Realistic values should be output on the serial console by all the components.		Luis Guevara
Website	This subsystem is a compilation of all the website UI components, and AWS services working together		Edwin Hernandez
Video recording subsystem	The video confirmation consists of a camera. This will be interfaced onto the microcontroller. The device will only turn on when the fire detection subsystem has been alerted of a fire. It will record a video, save it onto an SD card, and send it through the cloud.		Lluviana Vasquez
Fire Spread Direction and Speed subsystem	This subsystem will detect the direction and speed of the wind to predict the direction and speed of the fire spread and transmit that info to the website.		Matthew Wilson
Active Cooling and Air Sampling Subsystem	This subsystem will constantly suck in fresh air from outside the device and blow the air over the processor and sensors to actively cool the system and provide new air samples for fire detection.		Matthew Wilson

3. Test Approach(s)

Individual units are now compiled together into their appropriate subsystems. Each subsystem will be given the input it needs to drive the logic. For the fire detection, location, and video recording subsystems, the subsystems will be outdoors, exposed to a controlled burning fire. The subsystems will be verified to be in working order with the help of the Arduino serial console. The Query Debugging subsystem will be tested by giving the serial console an input that activates the debugging mode. All components should be polled, and the values will be output on the Arduino serial console.

4. Test Cases

Fire Detection Subsystem

Description: Units that help detect a wildfire will be integrated. The subsystem will be exposed to the fire, which will give it smoke and temperature as inputs. When one or all components activate, they will give an output to the Arduino serial console.

Location subsystem

Description: The GPS and GSM modules will be integrated and interfaced to the microcontroller. The location subsystem will be outdoors, tracking the location of the device using satellites and cell towers. These satellites and cell towers will provide the input to the location subsystem. The location subsystem will translate the inputs into readable coordinates, which will be verified on the Arduino serial console.

Query Debugging subsystem

Description: The Query debugging system will be a function that takes a command from the Arduino serial console. Once the command is entered, all components should be polled and their appropriate readings should be output.

Website

Description: The website system will be the interface that the user interacts with to view the data collected by the hardware devices.

Video recording subsystem

Description: The camera will be integrated onto the microcontroller. It will turn on only when a fire is detected by the fire detection subsystem. Once it is on, it will record a video and begin to save it onto an SD card which will then send it through the cloud. This will be verifiable through the website.

Fire Spread Direction and Speed Subsystem

Description: The units will be exposed to fire and transmit the wind speed and direction to the website to be verified.

Active Cooling and Air Sampling Subsystem

Description: The units will be exposed to fire and the fan will increase rpm to cool the system.

5. Test Regulatory/Mandate Criteria

Not applicable

6. Test Pass/Fail Criteria

Fire Detection subsystem - Pass: sensors sense smoke and excessive heat, code sets sensors flag to “fire detected” and output is seen on the Arduino serial console. Fail: sensors do not sense smoke nor excessive heat, and there is no output on the Arduino serial console.

Location subsystem - Pass: Both modules return the GPS location and GSM location, verified on the serial console. Fail: No location is returned or garbage location is returned by one or both modules.

Query Debugging subsystem - Pass: Readings of all components is output after giving the serial console the debugging input. Fail: No readings are output on the serial console after giving the serial console the debugging function input.

Website – Pass: Can view the device data and receive updates. Fail: No readings of device data are not showing and no notifications.

Video recording subsystem – Pass: The camera returns a video recording through the cloud which can be verified on the website. Fail: No video recording is sent through the cloud and cannot be verified on the website.

Fire Spread Direction and Speed Subsystem – Pass: Wind direction and speed are correct and are visible on the website within a minute. Fail: Wind readings are inaccurate or fail to be transmitted to the website within a minute.

Active Cooling and Air Sampling Subsystem – Pass: System internals are kept below 80 degrees C in the presence and absence of fire. Fail: System internals reach 80 degrees C.

7. Test Entry/Exit Criteria

Fire Detection subsystem - Begin testing when sensors are all interfaced to microcontroller, and when the respective code for the components is integrated. Stop testing when 10 consecutive successful trials have occurred when exposing the sensor to smoke and heat.

Location subsystem - Begin testing when GPS and GSM modules are interfaced to the microcontroller, and when the respective code for the modules is integrated. Stop testing when the location returned by the GPS and GSM module is verifiable.

Query Debugging subsystem - Begin testing when code polling all integrated components is written and uploaded on the microcontroller. Stop testing when there is output for all components polled.

Website – Begin testing when user/non-user/troubleshooter accesses the website. Stop testing when there are no issues with viewing device data.

Video recording subsystem – Begin testing when the camera is interfaced to the microcontroller and the respective code is integrated. Stop testing when a video is sent through the cloud and it is verifiable on the website.

Fire Spread Direction and Speed Subsystem – Begin when anemometer and wind vane are integrated with the processor and the software is installed. Stop when the sensor values are verifiably transmitted to the website.

Active Cooling and Air Sampling Subsystem – Begin when the fan and temp/humi sensors are integrated with the processor and the software is installed. Stop after monitoring the processor temperature for 5 minutes.

8. Test Deliverables

Fire Detection subsystem - A video demonstrating smoke and heat triggering the components will be provided. In the video, after the sensors are triggered, output confirming that the Fire Detection subsystem is working will be shown. This will verify that the integrated units are functional.

Location subsystem – A video demonstrating the GPS/GSM modules getting coordinates will be provided. The coordinates will be output on the serial console and will be verified by confirming them with my current location's coordinates. This will verify that the integrated units are functional.

Query Debugging subsystem - A video demonstrating the debugging routine will be provided. The debugger will enter the command to poll all sensors and the outputs will be shown on the serial console.

Website – A video demonstrating each role view and viewing the data.

Video recording subsystem – A video demonstrating the camera sending the video through the cloud and onto the website will be provided. We will also verify it has successfully saved on the SD card for extra measure.

Fire Spread Direction and Speed Subsystem – A video demonstrating the system measuring and transmitting wind data.

Active Cooling and Air Sampling Subsystem – A video demonstrating the subsystem regulating the system's internal temperature.

9. Test Suspension/Resumption Criteria

Fire Detection subsystem - Suspend testing when if any or all sensors malfunction due to extreme heat from the fire, or when it becomes a fire hazard. Resume testing when functional components of the Fire Detection subsystem are interfaced and integrated to the microcontroller and there is no fire hazard.

Location subsystem – Suspend testing when no values or garbage values are output by the modules after 10 minutes. Resume testing when code has been revised.

Query debugging subsystem – Suspend testing when no values are output when the debugging command is given to the serial console. Resume testing when code has been revised.

Website: Suspend testing when no values are showing/ being updated. Resume testing when code has been revised.

Video recording subsystem – Suspend testing when the camera malfunctions and it is not detectable by the code. Resume testing once the code has been revised.

Fire Spread Direction and Speed Subsystem – Suspend when there is no wind or components fail. Resume when there is wind and components are functional.

Active Cooling and Air Sampling Subsystem – Suspend if internal temp reaches 80 degrees C. Resume after correcting the software/hardware and the system has cooled down.

10. Test Environmental/Staffing/Training Needs

As for the environment, a grill or fireproof receptacle outdoors will be needed. This will contain the fire that will be the input to the device. A fire extinguisher is required when lighting a fire. To test the subsystems, a computer with the Arduino serial terminal will be needed. Knowledge of the Arduino serial console and how to navigate around it is necessary. Knowledge of fire safety is also required.

H. System Testing

1. Test Risks/Issues

Besides the fire hazards detailed in earlier sections, there is no other physical risk. Every component should be interfaced and integrated correctly at this stage of development. Some errors that were not caught by integration testing can appear, such as components malfunctioning or code not doing the function it is supposed to do.

2. Items to be Tested/Not Tested

Item to Test	Test Description	Test Date	Responsibility
Wildfire detection device	The device will be turned on. It will then be exposed to a controlled burning fire. The device should trigger and detect the presence of fire. This information and readings from all components will then be sent to the website.		All

3. Test Approach(s)

In this stage of development, the whole unit that is fully integrated will be tested. The device will go through tests where it is exposed to a controlled fire. The device should detect a fire and should send that information as well as associated component readings. On the database side, the readings of the components will be verified.

4. Test Cases

Wildfire Detection device

Description: The device will be deployed outside, and it will use cell towers, satellites and a fire as its inputs. The device will be turned on, then will be exposed to a fire, which it should detect. The temperature, location, and fire detection flags should then be sent to a database. It will also send a video to be able to view it in real time.

5. Test Regulatory/Mandate Criteria

Not applicable

6. Test Pass/Fail Criteria

Wildfire Detection device - Pass: location of the device is found and sent to the database. Components sense smoke and excessive heat, code sets sensors flag to “fire detected” and output is seen on the database. Video recording successfully is sent to the website. Fail: No location is retrieved, components do not sense smoke nor excessive heat, no video of the fire is sent, and there is no output on the database.

7. Test Entry/Exit Criteria

Wildfire Detection Device - Begin testing when the device is one unit, and every component is integrated. Stop testing when 10 consecutive successful trials have occurred.

8. Test Deliverables

Wildfire Detection device - A video outdoors demonstrating smoke and heat triggering the device will be provided. In the video, after the device is triggered, output on the website confirming that the Wildfire Detection device is working will be shown. This will verify that the device is functional.

9. Test Suspension/Resumption Criteria

Wildfire Detection device - Suspend testing when any or all components don’t give a reading and don’t output the readings to the database. Resume testing when device has been reset by turning it off then on.

10. Test Environmental/Staffing/Training Needs

As for the environment, a grill or fireproof receptacle outdoors will be needed. This will contain the fire that will be the input to the device. A fire extinguisher is required when lighting a fire. To test the device, it will be exposed to fire. Knowledge of fire safety is also required.

I. User Acceptance Testing

1. Test Risks/Issues

2. Items to be Tested/Not Tested

Item to Test	Test Description	Test Date	Responsibility
Wildfire Detection Device	The device will be turned on. It will then be exposed to a controlled burning fire.		All

	The device should trigger and detect the presence of fire. This information and readings from all components will be then sent to the database.		
Website	The website is the component that allows the users to view the data from the hardware devices.		Edwin Hernandez

3. Test Approach(s)

In this stage of development, we assume the consumer will be ready to operate the device. The device will go through tests where it is exposed to a controlled fire. The device should detect a fire and should send that information as well as associated component readings. This information should be sent to the website, which the consumer can verify by visiting the site.

4. Test Cases

Wildfire Detection device

Description: The device will be deployed outside, and it will use cell towers, satellites and a fire as its inputs. The device will be turned on, then will be exposed to a fire, which it should detect. The temperature, location, and fire detection flags should then be sent to the website. A video will also be sent in real time to display how the fire looks like.

Website

Description: The website will be the interface that the user interacts with to view the data collected by the hardware devices.

5. Test Regulatory/Mandate Criteria

Not applicable

6. Test Pass/Fail Criteria

Wildfire Detection device - Pass: location of the device is found and sent to the website. Device detects a fire; output is seen on the website. Fail: The device is in the presence of a fire, but no indication is being output on the website.

Website – Pass: Can view the device data and receive updates. Fail: No readings of device data are not showing and no notifications.

7. Test Entry/Exit Criteria

Website – Begin testing when user/non-user/troubleshooter accesses the website. Stop testing when there are no issues with viewing device data.

8. Test Deliverables

Website – A video demonstrating each role view and viewing the data.

9. Test Suspension/Resumption Criteria

Website: Suspend testing when no values are showing/ being updated. Resume testing when the code has been revised.

10. Test Environmental/Staffing/Training Needs