Revision Log

<table>
<thead>
<tr>
<th>Revision</th>
<th>Description</th>
<th>Date</th>
</tr>
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<tbody>
<tr>
<td>A/B</td>
<td>Conceptual and Preliminary Design Review</td>
<td>10/14/2014</td>
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</tbody>
</table>

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1.0 Mission Overview

1.1 Mission Statement:

The overall mission for project RadSat is to construct a payload to be sent to 30 kilometers on the 15th of November in 2014 to collect data on the electromagnetic spectrum. While remaining under the maximum cost, mass limitations, and at the functioning temperature, Team RadSat 3000 is seeking to measure electromagnetic radiation across the spectrum from infrared radiation to gamma rays using various sensors in order to gain a better understanding of the effects of radiation on humans. Upon completion of the flight, Team RadSat 3000 expects to recover all hardware in functioning condition. The team would then be able to create an informative correlation between the increase in altitude and the amount of radiation exposure, as demonstrated by common daily exposure or radioactive events that humans experience.

1.2 Mission Objectives:

On Earth, humans are exposed to radiation constantly from the sun. This radiation is known as background radiation. Generally this radiation is not harmful due to the atmosphere’s natural scattering, reflection and refraction. As the BalloonSat rises above the safety of the troposphere, there is a much higher amount of cosmic radiation. (Source 7)

In order to help expand the current understanding of radiation, the collection of more data is essential. It is this fact that inspired Team RadSat 3000’s mission. Team RadSat 3000 will measure radiation data and compare the results to known effects on a human being. Team RadSat 3000 intends to measure radiation levels at observed altitudes in order to provide insight into the dangers a human may face. Team RadSat 3000 will also measure UV exposure in order to link the altitudes at which the UV index changes. The risks of skin damage for particular skin types may then be determined. Invisible infrared radiation poses a threat to human eyes, as well as certain medical implants, including Cochlear Implants. IR radiation is generally manifested through heat due to molecular kinetic energy. In the near vacuum and low temperatures of RadSat 3000’s flight profile, a more accurate measurement of IR irradiance can be measured.

While analyzing the data and comparing it with research, Team RadSat 3000 will determine the altitudes at which common radiation and UV exposures occur and link the recorded data to radiation and UV exposures that humans experience daily on Earth. Altitude will be measured using a simple mathematical conversion using data from the pressure sensor. Team RadSat 3000 will compare the exposure and intensity of electromagnetic radiation as a function of altitude (Source 8). The intensity of gamma and high energy beta radiation will be measured through the Geiger counter, the intensity of UV radiation with the UV sensor, and the infrared radiation via the IR sensor. After obtaining this data, team RadSat 3000 will identify a connection between the recorded data to radiation and UV exposures that humans experience daily on Earth.
By measuring and recording the radiation and UV exposure, Team RadSat 3000 aims to create an informative connection between increases in altitude and common daily exposure or radioactive events that humans experience.

2.0 Requirements Flow Down

2.1 Level 0 Objectives

<table>
<thead>
<tr>
<th>Objective</th>
<th>Mission Objective</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>OBJ 1</td>
<td>The payload shall rise to an altitude of 30 kilometers.</td>
<td>Mission Statement</td>
</tr>
<tr>
<td>OBJ 2</td>
<td>The satellite shall sustain an internal temperature above -10°C.</td>
<td>Mission Statement</td>
</tr>
<tr>
<td>OBJ 3</td>
<td>The expenses and mass shall not exceed $250 and 1,125 grams, respectively.</td>
<td>Mission Statement</td>
</tr>
<tr>
<td>OBJ 4</td>
<td>The radiation data shall be collected throughout the duration of the flight via IR, UV, and Geiger Counter sensors.</td>
<td>Mission Statement</td>
</tr>
<tr>
<td>OBJ 5</td>
<td>The payload shall be recovered safely in ready-to-fly condition.</td>
<td>Mission Statement</td>
</tr>
<tr>
<td>OBJ 6</td>
<td>Team RadSat 3000 shall analyze the data collected via the onboard sensors</td>
<td>Mission Statement</td>
</tr>
</tbody>
</table>

3.0 Design

3.1 Design Overview

Team RadSat 3000 will construct a satellite with a foam core structure held together by hot glue at the seams, and lined with aluminum tape at the edges. The insulation will include 25.4 mm black foam and aluminized Mylar placed between the foam core and insulation to prevent radiation damage and damage from low temperatures. The satellite will contain eight sensors: an accelerometer, a compass, a pressure sensor, a humidity sensor, two temperature sensors, a Geiger counter, a UV sensor, and an IR sensor. To prevent cold temperatures from causing the sensors to fail, the heater will be placed near the batteries and also relatively close to the two Arduino Unos. Any holes made for the sensors and the camera will be deliberately placed on the opposite side of the heater to prevent warm air from bleeding out of the payload. The UV and IR sensor will be pointed upwards towards the sun in order to receive the most accurate data. The payload will contain three switches with visual representations in the form of Crawford Leeds 10/25/2014 6:37 PM
Comment [10]: What about level 1 or level 2 reqs?

Crawford Leeds 10/25/2014 6:38 PM
Comment [11]: If the balloon doesn’t work is this a failure on your side? This requirement is ours, your requirement is just to mount to the balloon.

Crawford Leeds 10/25/2014 6:38 PM
Comment [12]: Any maximum?

Crawford Leeds 10/25/2014 6:38 PM
Comment [13]: 225$

Crawford Leeds 10/25/2014 6:37 PM
Comment [14]: Does it have to be recoverable in that condition or just fixed in the end?

Crawford Leeds 10/25/2014 6:38 PM
Comment [15]: Be way more specific.

Crawford Leeds 10/25/2014 8:39 PM
Comment [16]: Digital compass
three LED’s to show that the two Arduinos and the heater are active and running at the time of launch. Running through the center of the payload, a non-metal flight tube will serve as a route for the paracord, connecting the payload to the weather balloon, GPS system, and all other payloads included on the launch. On the lower side of the payload, an aluminum washer and paperclip will secure the flight tube and disperse the force among the whole under side of the payload so that it will not pull through the BalloonSat or interfere with the flight string. The BalloonSat will be positioned on the flight string by tying two knots on each side of the payload. The outer structure will contain stickers displaying the United States flag, the University of Colorado at Boulder logo, and the Team RadSat 3000 logo. It will also contain contact information in case the payload is lost during the flight.

Comment [17]: What material is it?
3.2 Hardware Overview

**Geiger Counter (SEN-11345 ROHS):**

The main objective of the mission involves using a Geiger counter that will be purchased from a blog titled “MightyOhm.” The Geiger counter will be integrated with the Arduino Uno by connecting it to the 5V port. The Geiger counter will obtain a reading by connecting the Geiger tube to its circuit board with two wires on each end of the tube and horizontally placing the tube parallel to the wall into a slice in the BalloonSat foam core which will allow radiation to come into contact with it. The Geiger counter functions in a unique way. Team RadSat 3000 purchased the SBM-20 Geiger Muller Tube with a 50 mkm stainless steel cathode material and therefore only measures gamma and high energy beta particles due to the fact that alpha particles have an inability to travel through metal. The sealed tube is filled with lower pressure inert gases including neon, bromine, and argon (Ne, Br₂, Ar). The tube contains a thin metal wire running down the center of the tube which is electrically insulated from the outside environment. Therefore, particles must penetrate the stainless steel shell to produce a count; this is called energy discrimination. The wire and the cylindrical shell have a potential difference of 1 kV. When incoming ionizing radiation comes into contact with the inert gasses inside the tube, the molecule breaks down into a free electron and a positively charged ion. The negatively charged electron travels to the positive anode, the metal wire, and the ion travels to the cathode, the cylindrical shell. When the electron encounters the anode, the electric field and the accelerating force increases. If the electron has a high enough acceleration, it may excite or ionize other electrons of the inert gas. An excited electron emits photons that trigger further ionization which is termed the avalanche effect. There is then a reduction in the anode, and an increase at the cathode, thus sending a signal to the Geiger counter as a count. (Source 1, Source 2, Source 6)

![Figure 3.2 Geiger-Muller Tube Function Diagram](image)

**UV Sensor Breakout - ML8511 (SEN 12705 ROHS):**

This UV sensor created by SparkFun most effectively detects 280 nm to 390 nm wavelengths. The sensor detects the UV rays that come into contact with it and creates an analog voltage signal that is linearly related to the UV intensity. In order to collect UV data, the Arduino
Uno must be programmed to convert the analog signal. The UV Sensor will be connected to the Arduinos 3.3V source. (Source 5)

**IR Sensor:**

The infrared radiation sensor will be constructed by the team. The primary receiver will be at least one infrared phototransistor. The phototransistor will be connected to a dedicated circuit which will use a combination of resistors to limit the voltage output from 0 volts to 5 volts in order to properly interact with the Arduino Uno. Infrared irradiance will be measured based on the voltage output from the phototransistor and resistor circuits. The team will make several observations at ground level in order to establish a baseline for the sensor. The team will calculate the proper levels of resistance needed to make meaningful measurements at all altitudes of the mission. (Source 11)

**Aluminized Mylar:**

The purpose of the aluminized Mylar is to preserve heat, reflect radiation, and act as the skeleton for the payload. The aluminized Mylar sheet will be placed between the rigid exoskeleton of the payload and the 12.7 mm foam core in order to preserve heat inside the structure and to prevent radiation from penetrating the payload and destroying the instruments, therefore keeping the internal temperature above -10°C. It will not obstruct the hole for which the Geiger tube will be pointed out of for it will be behind the Geiger counter entrance tube. The sheet will be bought from Amazon as an Emergency Blanket in a 4-pack of 214 cm x 132 cm sheets which will be trimmed down to line the Styrofoam insulation.

**Canon A3400 IS Digital Camera:**

The payload will contain a small digital camera that will record images every twenty seconds throughout the duration of the flight. The purpose of incorporating the camera is solely for observation and increased awe of the beauty in space and to see what different altitudes in space look like.

**Temperature Sensors:**

The payload will incorporate two temperature sensors. One will record the internal temperature of the payload and the other sensor will be placed externally to record external temperatures. A small incision in the structure will be cut in order to place the sensor slightly outside the payload to capture data on the external temperature.

**Pressure Sensor:**

The pressure sensor will be the principal relation between pressure and altitude. Using a known formula to convert pressure to altitude, the team will be able to relate the radiation sensor’s data with the recorded altitudes.
3-Axis Accelerometer:
The accelerometer will measure the dynamic motion of the BalloonSat. Motion, shock, and vibration will be measured to provide a better understanding of the flight and forces acting on the satellite.

Compass:
The compass will show the heading of the BalloonSat relative to the magnetic north pole of Earth.

Humidity Sensor:
The humidity sensor will measure relative humidity at all altitudes throughout the flight.

3.3 Concept of Operations Diagram (CONOPS):

Comment [18]: Not a huge deal but it usually makes sensor to follow a path from left to right.
3.4 Functional Block Diagram:

![Functional Block Diagram](image)

Comment [19]: What connects the components together? Structure, power, electrical signals?
4.0 Management:

Team RadSat 3000 will have a minimum of two meetings during the week at established times determined on Sundays and will have at least one meeting either on Saturday or Sunday, determined by availability.

4.1: Responsibilities

<table>
<thead>
<tr>
<th>Name</th>
<th>Role</th>
<th>Email</th>
<th>Phone #</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amber Bishop</td>
<td>Research, Structural Design, Coding</td>
<td><a href="mailto:amber.bishop@colorado.edu">amber.bishop@colorado.edu</a></td>
<td>805-797-5470</td>
</tr>
<tr>
<td>Markus Fuernkranz</td>
<td>Software, Coding</td>
<td><a href="mailto:markus.fuernkranz@colorado.edu">markus.fuernkranz@colorado.edu</a></td>
<td>408-916-6113</td>
</tr>
<tr>
<td>Matthew Jensen</td>
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<td><a href="mailto:matthew.jensen@colorado.edu">matthew.jensen@colorado.edu</a></td>
<td>815-739-4993</td>
</tr>
<tr>
<td>James Madok</td>
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<td><a href="mailto:jama3279@colorado.edu">jama3279@colorado.edu</a></td>
<td>303-949-0654</td>
</tr>
<tr>
<td>Sam O’Donnell</td>
<td>Computer &amp; Data Handling, Research</td>
<td><a href="mailto:samuel.odonnell@colorado.edu">samuel.odonnell@colorado.edu</a></td>
<td>858-699-5201</td>
</tr>
<tr>
<td>Natalia Rodriguez</td>
<td>Power, Coding</td>
<td><a href="mailto:natalia.rodriguez@colorado.edu">natalia.rodriguez@colorado.edu</a></td>
<td>787-236-2385</td>
</tr>
<tr>
<td>Ruben Vega</td>
<td>Structural Design</td>
<td><a href="mailto:ruben.vega@colorado.edu">ruben.vega@colorado.edu</a></td>
<td>925-586-1561</td>
</tr>
<tr>
<td>Edward Zuzula</td>
<td>Manager, Coding, Data Handling</td>
<td><a href="mailto:edward.zuzula@colorado.edu">edward.zuzula@colorado.edu</a></td>
<td>210-885-2902</td>
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</table>

Comment [20]: Should put team lead at the top to give it better flow.
### 4.2 Project Schedule:

#### PRE-LAUNCH

<table>
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<th>Date</th>
<th>Event:</th>
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<tbody>
<tr>
<td>58</td>
<td>9/18</td>
<td>CoDR Presentations (DUE by 7:00 am)</td>
</tr>
<tr>
<td>52</td>
<td>9/21</td>
<td>Finish HW05 and RFP by 6:00 pm</td>
</tr>
<tr>
<td>53</td>
<td>9/22</td>
<td>Request for Proposal DUE by 8:00 am</td>
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<tr>
<td>54</td>
<td>9/23</td>
<td>HW05 DUE (micro SD card shields &amp; sensors)</td>
</tr>
<tr>
<td>55</td>
<td>9/24</td>
<td>Finish HW06</td>
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<tr>
<td>49</td>
<td>9/26</td>
<td>Authority to Proceed Appointments / Hardware Order Forms DUE (HW06)</td>
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<tr>
<td>47</td>
<td>9/28</td>
<td>Finish HW07</td>
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<tr>
<td>45</td>
<td>9/30</td>
<td>HW07 DUE (Heater Build)/ Finish HW08</td>
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<td>44</td>
<td>10/01</td>
<td>Acquire All Hardware</td>
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<tr>
<td>41</td>
<td>10/04</td>
<td>Complete BalloonSat (Structure and layout) / Begin Testing</td>
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<tr>
<td>33</td>
<td>10/12</td>
<td>Finish Testing (Whip, Drop, Stair-Pitch, Cold, Vibration)/ Complete PDR and practice presentation/ Complete DD Rev A/B</td>
</tr>
<tr>
<td>31</td>
<td>10/14</td>
<td>Preliminary Design Reviews (DUE by 7:00 am)/ DD Rev A/B due</td>
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<tr>
<td>29</td>
<td>10/16</td>
<td>HW08 DUE (System Engineering Exercise)</td>
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<tr>
<td>22</td>
<td>10/23</td>
<td>Mid Semester Team Evaluations DUE</td>
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<tr>
<td>14</td>
<td>11/01</td>
<td>Finish Coding (Sat should be +99% finished) / Fully Functional Test</td>
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<tr>
<td>11</td>
<td>11/04</td>
<td>Finish Service Proposal</td>
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<td>9</td>
<td>11/06</td>
<td>Service Proposals DUE</td>
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<tr>
<td>6</td>
<td>11/09</td>
<td>Finish LRR and practice presentation</td>
</tr>
<tr>
<td>4</td>
<td>11/11</td>
<td>Launch Readiness Review Presentations (DUE by 7:00 am)/ Finish DD Rev C</td>
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<tr>
<td>3</td>
<td>11/12</td>
<td>Finish RFF Card</td>
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<td>2</td>
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<td>DD Rev C DUE by 4:00 pm</td>
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<td>RFF Cards DUE/ BalloonSat Weigh-In and Turn In</td>
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<td>LAUNCH DAY: leave Boulder, CO at 4:45 am</td>
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<tr>
<td>11/18</td>
<td>Complete PLP and Practice Presentation</td>
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<td>Post Launch Presentations (DUE by 7:00 am) + Bring Raw Flight Data</td>
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<td>12/04</td>
<td>Complete 1st Draft of DD Rev D and prepare for ITLL Expo</td>
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<td>12/06</td>
<td>ITLL Design Expo (9:00 am - 4:00 pm) / 1st Draft of DD Rev D</td>
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<td>12/07</td>
<td>Complete Final Presentation</td>
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<td>12/09</td>
<td>All Data DUE in class / Final Presentations (DUE by 4:00pm)/ Complete HW10</td>
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<tr>
<td>12/11</td>
<td>Hardware DUE in class/ HW10 DUE (Expectations Met, Resume, and Letter)/ Final Team Evaluations DUE</td>
<td></td>
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<tr>
<td>12/13</td>
<td>Complete Final DD Rev D</td>
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<tr>
<td>12/15</td>
<td>Final DD Rev D DUE by 1:30 pm</td>
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## 5.0 Budgets:

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<tr>
<td>Aluminized Mylar</td>
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<td>King Soopers</td>
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<td>UV Sensor</td>
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<td>Circuits Lab</td>
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<tr>
<td><strong>TOTALS:</strong></td>
<td></td>
<td>885.2 g</td>
<td>$120.57</td>
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</tbody>
</table>

* Mass is considered in grams.

** All purchases will be confirmed by manager, Edward Zuzula prior to submission of the order form and will be purchased with Chris Kohler's CU Visa Card.

*** All COSGC hardware must be returned in working condition.
6.0 Test Plan and Results

6.1 Safety:
Throughout the duration of this semester, each team member shall act professionally when working with the BalloonSat. Each test shall be performed in an appropriate environment where no harm could occur for a person or CU Boulder property. This means that all bystanders will be clear of the testing area, and the tests will not be performed near windows. Each team member shall be dressed appropriately for their work. Each team member shall have complete knowledge of a tool and the safety parameters for using it prior to use. If they are uncertain, they must go to an instructor to be supervised or taught how to use the tool or instrument.

6.2 Testing:
Structural Test:
The structural tests are performed in order to determine that the structure containing the payload will survive the flight and will keep the payload safe. A series of three tests comprise the structural test: whip test, drop test, and stair-pitch test. Each test is performed with the satellite structure containing an appropriate amount of rocks to simulate the mass of the contents of the satellite.

- The whip test simulates the post-burst environment when the payload will undergo the maximum g-forces during the flight. Team RadSat will attach the payload to paracord to simulate the flight string cord running through the center of the payload with two knots on each end. The payload will be spun above the tester’s head as fast as possible and with abrupt directional change. This test shall not take place near any windows or while bystanders are present in the area.
- The drop test simulates a worst-case landing where the parachute fails to inflate upon descent. The structure will contain the mass of the payload and will be dropped from 4.5 to 6 meters onto a hard surface to test the structural rigidity. Bystanders will be clear of the area prior to drop testing.
- The stair-pitch test represents another worst-case landing where the downwind inflates the parachute upon landing and drags the payload across the ground, possibly hitting rocks or tumbling down a hill. The stair-pitch test will be performed by pitching the structure with the proper mass down a full flight of steps.

Functional Tests:
The functional tests are performed to confirm that all systems will work appropriately and fulfill their purpose throughout the entire duration of the flight. Functional tests include simulating the harsh environment near 30 kilometers, and simply confirming that the sensors function correctly.

- The thermal test consists of 3 to 5 kilograms of dry ice placed in a cooler covered with a non-conductive material between the dry ice and the payload. The payload will be placed onto the non-conductive material just over the dry ice, the lid of the cooler will be shut, and the payload will sit in the cooler for at least 4 hours, turning it to each of its six sides.
every 40 minutes. This test will insure functionality and battery life under extremely low temperatures. This will also serve as a functional test for the temperature sensor and logger as the payload will be running and tracking temperature data.

- The altitude test will experiment with the pressure sensor, the accelerometer, the compass, and the humidity and temperature sensor by taking the payload up into a skydiving airplane to approximately 5.5 kilometers above sea level. The test will simulate a decrease in temperature, pressure, and humidity, and the accelerometer and compass shall track the flight. However, the payload will not be leaving the airplane.

- The UV sensor will be tested by running the sensor outdoors with sun exposure. Team RadSat 3000 will look up the UV index for the day and compare the reading with the result. If time and budget permit, readings will be taken at higher altitudes in a skydiving airplane to get more accurate calibration.

- The IR sensor will be tested and calibrated by taking multiple readings at ground level at various levels of sunlight to establish baselines for the sensor. If time and budget permit, readings will be taken at higher altitudes in a skydiving airplane to get more accurate calibration.

- The Geiger counter will be tested by using a similar Geiger counter to measure radiation and then compare the two. Common table salt contains a small amount of a radioactive isotope called Potassium-40, which is able to be measured using a Geiger counter. RadSat 3000 will test Geiger Counter 2 at the same time as the Geiger counter that RadSat 3000 constructed to make sure that it reads radiation properly. Because Geiger Counter 2 insures proper readings, the functioning Geiger counter constructed by Team RadSat 3000 shall have the same output.

- The Camera functionality will be tested during the thermal testing and will also undergo functional testing to ensure that no part of the satellite will obstruct the images. Photos will be taken at intervals of twenty seconds.

7.0 Expected Results:

Team RadSat 3000 shall save all recorded measurements to the micro SD cards. Team RadSat 3000 will then convert the recorded data to a .csv file for compatibility with Microsoft excel. From the .csv file, Team RadSat 3000 can then confirm or refute their expected results.

7.1 COSGC Provided Sensors:

Temperature - Team RadSat 3000 expects to see the temperature readings drop until the BalloonSat exits the troposphere. As altitude increases into the stratosphere temperature is expected to increase.

Humidity - Team RadSat 3000 expects humidity to be directly related to the measured temperature. Additional sources of humidity may be due to condensation forming on the inside of the BalloonSat due to external and internal temperature differentials. Such information may be useful in diagnosing failures, especially in the electronic instruments.
Pressure - Team RadSat 3000 expects to see an inverse relationship between altitude and pressure. As the altitude increases, the pressure should decrease.

Accelerometer - Team RadSat 3000 expects to see a fairly constant velocity (zero acceleration) in the z-axis during ascent. Lateral motion is hard to predict, but the accelerometer will probably show slight oscillation as the launch cord sways back and forth. Upon burst, the accelerometer will show massive spikes in all three axes.

Compass - Based on review of previous BalloonSat flights, Team RadSat 3000 expects the compass to show rapid rotation.

7.2 Radiation CPM vs. Altitude:

Team RadSat 3000 expects to see an increase in counts per minute with an increase in altitude. The graph below, created by a man with a Geiger counter on a plane flight, accurately models what team RadSat 3000 expects to record (Source 4).

![Graph: Radiation Count Rate vs. Altitude]

The conversion of counts per minute to Sieverts is determined by the Muller Tube that is used (SBM-20). The counts that are recorded will be converted to Sieverts by the function: cpm \* 0.0057 = microSievert/hour (Source 10). From these values, Team RadSat 3000 can relate the levels of radiation at certain altitudes with common human exposure. For example, a chest CT scan will leave a human exposed to 7 mSv; therefore, Team RadSat 3000 can determine an altitude equivalent to the reading.
Radiation Dose Chart

This is a chart of the ranging radiation dose a person can receive from various sources. The unit for absorbed dose is "sievert" (Sv), and measures the effect a dose of radiation will have on the cells of the body. The smallest dose that will make you sick, and the dose that can cause death, is not shown on this chart. However, even small amounts of radiation can cause cancer over a long period of time.

Sources:
data for all sources are from, "Radiation Sources and Effects in Nuclear Power Plants" 2010 NUREG/CR-7010

Chart by Randall Murray, with help from Emily Senior Receptor Operator of the Head Receptor Reactor, who suggested the idea and provided a lot of the sources. I'm sure I've added in lots of mistakes. It's for general education only. If you're taking radiation safety classes, please don't do anything on an internet PWR website and things go wrong, you have no one to blame but yourself.
7.3 UV Intensity vs. Altitude:

Team RadSat 3000 expects data relative to the diagram below. It would make sense that as the BalloonSat increases in altitude, the UV radiation intensity will also increase due to a decrease in the absorbance by the atmosphere. From the graph, if the data displays as this example, Team RadSat 3000 will be able to determine the approximate altitude of the ozone layer. The altitude of the ozone layer may be determined by a sudden decrease in UV radiation, caused by an increase in density, a characteristic that the ozone layer contains. In this example, the ozone layer was determined to be at approximately 9000 m. Throughout the rest of the flight, the UV radiation intensity shall gradually increase. The apex of the graph is the point of burst. It may be seen that the intensity decreases more rapidly due to the high acceleration of freefall that the payload encounters after burst. The uneven increase in UV intensity may be associated with the rotation of the payload. As the sensor turns away from the radiation source, the sun, the data shows a sudden false decrease in intensity. Towards the end of the flight, it may be seen that the UV radiation intensity decreases as the payload reenters the troposphere (Source 3). With the data recorded, Team RadSat 3000 will evaluate the data to determine at what altitude the UV index measures. From the UV index, Team RadSat 3000 will be able to determine the damage caused to particular skin types. For example, at UV index 7, a white person that burns easily will have a very high risk of skin damage (Source 16).

![Graph of UV Intensity vs. Altitude](image)

**Figure 7.3:** Graph of UV Intensity vs. Altitude

7.4 IR vs. Altitude:

Because most of the infrared radiation is absorbed by water vapor and molecules in the atmosphere, (Source 13) collecting data at high altitudes will be beneficial and true to the mission of Team RadSat 3000. As infrared radiation has a wavelength of 0.7 to 300 µm, it is invisible to the human eye, yet it can be felt by humans. When the warmth of the sun is sensed,
humans are experiencing infrared radiation (Source 14). The lower atmosphere scatters the infrared radiation, yet in the upper atmosphere, there are less particles to scatter the infrared waves. Therefore, it can be expected that as the payload increases with altitude, the intensity of infrared radiation will increase. The team will determine whether or not there is a direct correlation between temperature and radiation at high altitudes. However, there may be increased levels of radiation which are not manifested by an increase in temperature.

8.0 Works Cited:
Source 1: http://gstube.com/data/2398/
Source 2: http://www.youtube.com/watch?v=bcjMOqiwA
Source 4: http://www.whatisnuclear.com/physics/radiation_on_flights.html
Source 5: https://www.sparkfun.com/products/12705
Source 6: http://www.bbc.co.uk/bitesize/intermediate2/physics/radioactivity/how_radiation_can_be_detected/revision/1
Source 7: http://web.princeton.edu/sites/ehs/osrattraining/backgroundradiation/background.htm
Source 9: http://cs.stanford.edu/people/nick/geiger/
Source 10: http://www.jameco.com/Jameco/Products/ProdDS/1872265.pdf
Source 11: http://abyss.uoregon.edu/~js/glossary/infrared.html
Source 14: https://bovineaerospace.files.wordpress.com/2014/01/radiation_sources.jpg
Source 16: http://www.weatheronline.co.uk/reports/wxfacts/The-UV-Index.htm

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