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February 21st, 2005

Dr. Lakshman One
School of Engineering Science
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Re: ENSC 440 Functional Specifications for an anti-theft/reminder transmitter

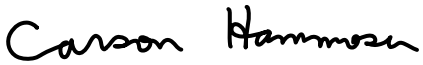
Dear Dr. One,

The following document, *Functional Specifications for an anti-theft/reminder transmitter*, provides an overview of the capabilities and scope of our project, the SafeGuard. The SafeGuard is an RF based, wireless tether which allows users to tag their personal items with RF transmitters. When these tagged items exit a predefined radius from the receiver, the receiver which is worn by the user, will notify the user which object was left behind.

The functional specifications will outline what we expect the abilities of our prototype to include and the degree of robustness we expect these abilities to achieve. The functional specifications will also indicate our primary, secondary and tertiary goals. Primary goals will be considered goals which must be accomplished at the prototype level. Secondary goals indicate goals which we hope to accomplish for a first generation final product. Finally, tertiary goals indicate goals we hope to implement in a second-generation prototype.

The functional specifications will be used in the future to help us in our design decisions, in terms of criteria for choosing parts and other design specifications.

Regards,



Carson Hammoser
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Enclosure: *Functional Specifications for an anti-theft/reminder transmitter*,

MNEMOSYNE
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Functional Specifications for an Anti-theft/Reminder Transmitter

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Executive Summary

Have you ever forgotten something or left something behind? Have you ever accidentally dropped something important? From keys and wallets, to glasses cases and cell phones, everyday people lose track of things. Items can be forgotten at work or home, or objects can be accidentally dropped or lost. Locating these items can often be frustrating as well as time consuming. Replacing them can be costly. Preventing these losses in the first place can eliminate the stress and aggravation associated with looking for these lost items. These annoying situations can be avoided by simply utilizing a small tracker which notifies you when you've left an object behind.

The application of a short range tracking system extends beyond helping you recover your lost items into the realm of security, protecting you from having your items stolen; a simple solution presents itself in terms of a range based security device, ensuring that your valuables remain close by at all times. This device can even be applied at a larger level in order to ensure that office equipment is not misused or removed from a specific location. Alternatively attaching tags to children and animals will allow you to keep track of your children and pets without having to attach chains or other physical tethers. This device will allow you to make sure that your kids stay close when you're in a busy shopping mall, or it will allow you to know when your dog escapes from the back yard.

Mnemosyne Technologies is proposing a project, the SafeGuard, where we will design and construct a multi-object tracking device. Utilizing our SafeGuard tags you can keep track of your personal effects. A receiver in the form of a watch or a keychain will track a specified number of tags, and notify you if you walk away from your tagged items. This warning will allow you to find out what you have left behind, since you will still be relatively close to the lost object.

The following document outlines the various functional components of the SafeGuard System. The development of the SafeGuard will occur in two primary stages: the prototype phase and the production phase. If time allows we will attempt to generate a second-generation prototype as well.

The prototype stage will:

1. notify users audibly when a tag is out of a 5 meter radius (with a 2 meter error margin)
2. use tags which transmit a unique 5 digit code
3. allow users to enter names for specific tags

The product stage will

1. meet specified size requirements for the receiver and tag respectively
2. include a case which encloses all circuitry
3. reach a level of robustness specified in the situational requirements

The second generate prototype stage if reached will include the following features:

1. low battery indicator for tags
2. user adjustable range
3. user adjustable time interval for sleep time

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1. Introduction

One of the many facts of life is that people lose things. People forget items or leave objects behind. Statistics show that people lose hundreds of thousands of objects every year. The SafeGuard is designed to help prevent a user from misplacing these objects, by reminding he/her that an item has been left behind while he/she is still relatively close to the item.

1.1. Scope:

The following document outlines the functional specifications of the SafeGuard. Required functions for the prototype will be rigorously outlined in the document. The functional specifications will also outline some potential abilities of the SafeGuard. Dependant on the implement-ability of the prototype, the prototype's final specifications may vary slightly from the functions outlined in this document. The functional specifications outlined will serve as a guideline for design decisions.

1.2. Goals:

The objectives for this project have been divided into three different segments: Primary goals, secondary goals, and tertiary goals. These goals correspond to the prototype stage, product stage, and second-generation prototype stage.

There are 3 primary goals for the prototype of the system.

1. The system will notify users audibly when a tag is out of a 5 ±2 meter radius.
2. The tags utilized by the system will transmit a digital code
3. The receiver unit will allow users to enter names for specific tags.

These minimum specifications are required to meet proof of concept requirements.

We will stipulate the specifications of the project more rigorously throughout the document. In order to denote a specific requirement, we will utilize the following notation:

[S *x*- *y*]

The *x* value will denote the stage of development the specification will be required for.

1. Prototype phase (primary goal)
   Any specification which is a primary goal will be a necessary requirement for the completion of the project.
2. Product phase (secondary goal)
   Any specification which is a secondary goal will be a requirement for the completion of a final product.
3. Second Generation Prototype (tertiary goal)
   Any specification which is a tertiary goal will be an objective whose completion will be dependent upon the amount of time available.

The *y* value will denote a reference number to the specification for future use.

2. System Overview

The Mnemosyne Technologies, wireless reminder system consists of two basic components: individual transmitter tags, and a receiver unit. The tags are attached to valuables or frequently misplaced items, while the receiver unit will be attached to a keychain, or simply placed in one's pocket. Ideally the receiver unit will be a watch or bracelet which people will be constantly wearing.

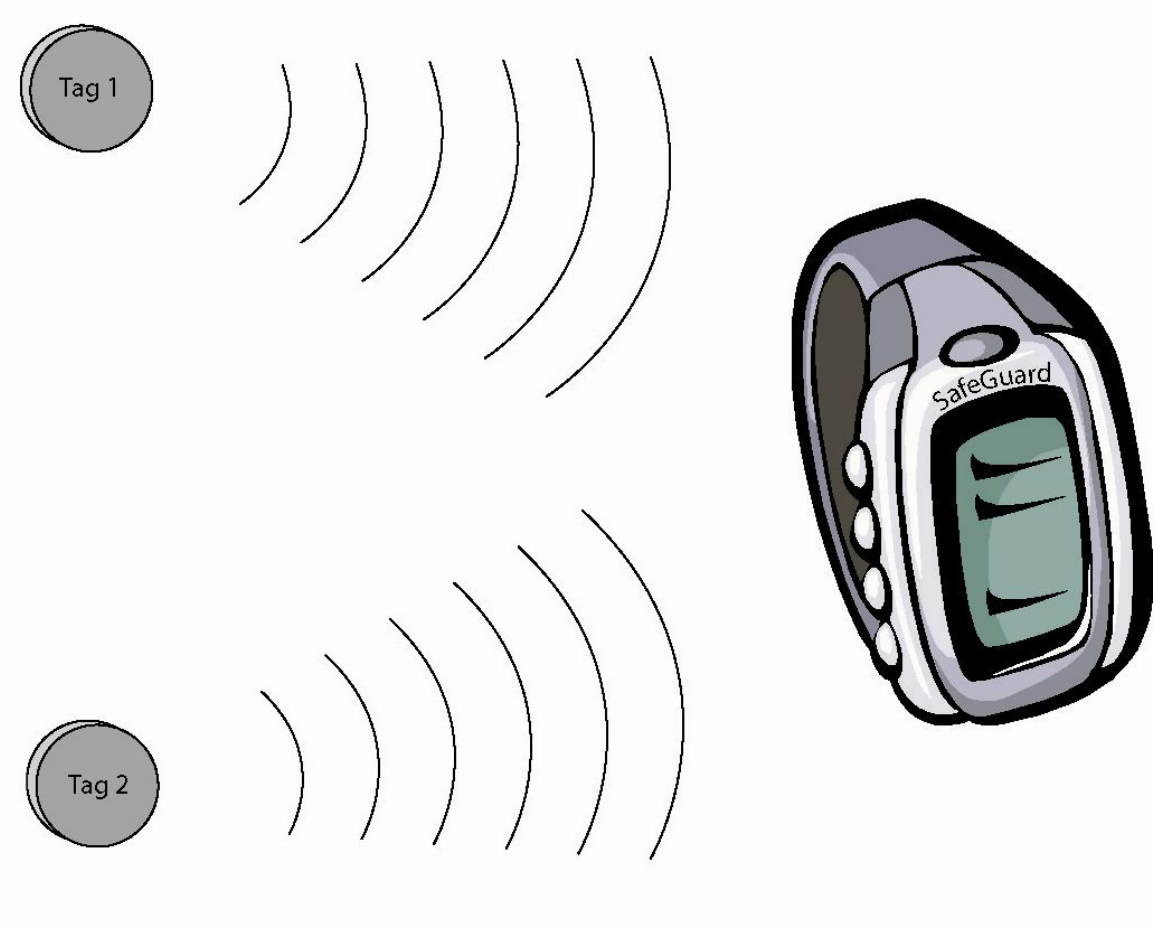

Figure 1: Basic Concept

To activate a tag, the user will place the receiver into an "activate" mode. The receiver will then try to identify the associated tags within range, based on their unique ID codes which have been stored in memory. The receiver will ask the user if he/she wants to activate or deactivate each stored item. The initialization is shown in Figure 2, below. Tag 1 is in range of the receiver and transmits a unique identification code to the receiver unit which is depicted as a watch. Once this initialization is complete, the receiver will automatically keep track of the active tags. The receiver will sound an audible and visible alert when a recognized tag is outside of its range, reminding the user that he or she has forgotten an item.

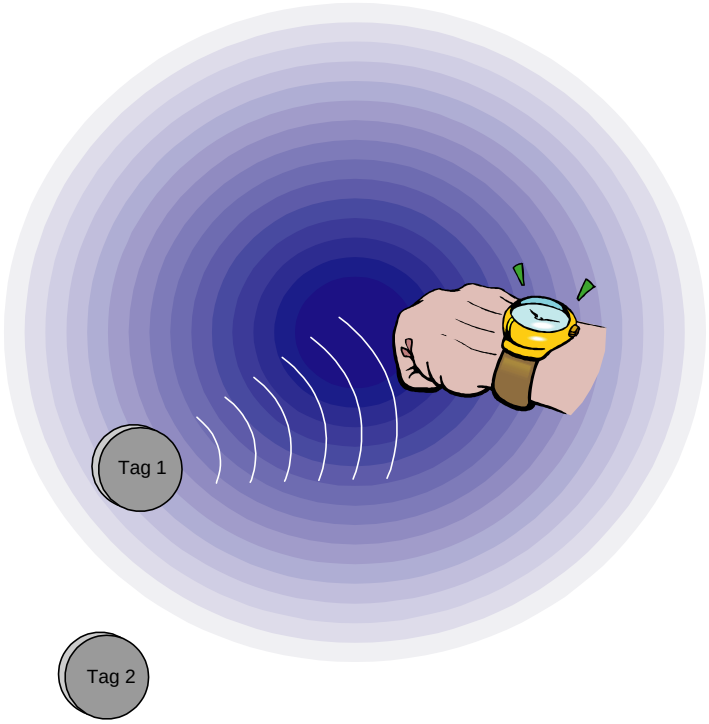

Figure 2: Possible Initialization Process

The main user interface contains four functions: Activate, Deactivate, and Sleep. Once the device warns the user about a forgotten item, the user can select either Sleep or Deactivate the missing tag. If the user selects Deactivate then the receiver will not poll for that item until the user selects Activate on that item again. On the other hand, if the user selects Sleep, the device will temporarily deactivate an object for a period of time. A full system operating flow chart is shown in Figure 3: Possible System Operation.

The main constraints in this project are the limited timeline and funding. Due to the limited funding, we might not be able to build the device as small as desired. However, we hope to build a prototype such that in theory the project can be scaled down to the desired size.

In the future, with additional time and funding, improvements to our prototype would be to minimize the size of the device or even combine it with a digital watch so the user does not have to carry an extra device. Additionally, we can extend the ability of the product to actually provide feedback to a user as to the actual location of their lost object. That is we can potentially extend the product to include locating technology. By including locating technology we can also expand the marketability of the SafeGuard.

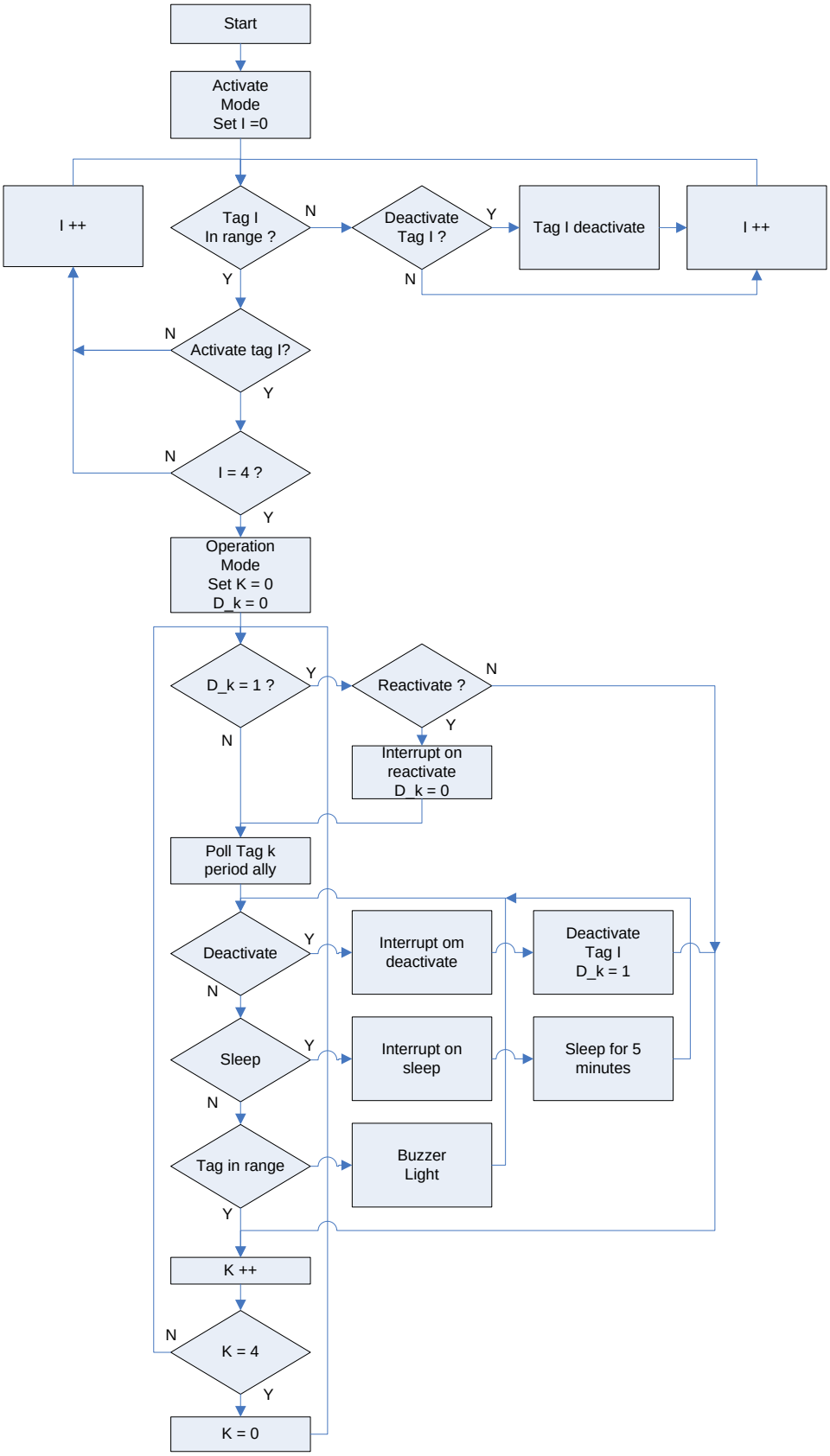

Figure 3: Possible System Operation

3. Tag Unit

In this section we will explain the requirements for this module of the project more rigorously.

3.1. Physical Requirements

We hope to achieve one of two possible tag dimensions. The first design has a rectangular shape. Our alternative tag shape has a cylindrical shape. The outlined dimensions do not include methods for attaching the tags to objects, such as a metal or plastic ring or loop of string or other material or other externally accessible structures such as switches.

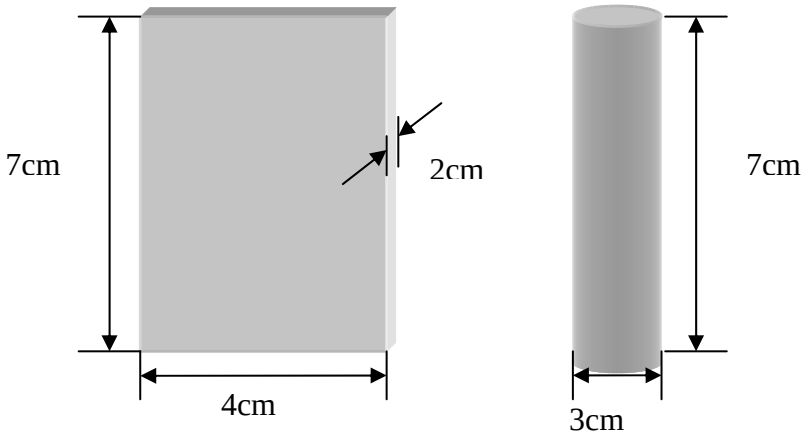

Figure 4: Potential Tag Shapes and Dimensions (Not to scale)

[S 1- 1] The weight of the tag with a battery will be at a maximum, 100 grams
[S 2- 1] The tag will be attachable to personal items using string or adhesive
[S 2- 2] The tag will have maximum dimensions of 7cm x 4cm x 2cm for a rectangular shape
[S 2- 3] The tag will have maximum dimensions of 7cm in length and a diameter of 2 cm for a cylindrical shape
[S 2- 4] The tag will have a casing that encloses all circuitry

3.2. Performance Requirements

[S 1- 2] According to Industry Canada RSS-210, our device must meet the following requirements:
"LPDs [Low Power Devices] *have intentional and unwanted emissions of very low signal levels such that they can co-exist with licensed radio services. LPDs are required to operate on a 'no-interference no-protection' basis, i.e. they may not cause radio interference and cannot claim protection from interference.*"

[S 1- 3] The tag will transmit for a range of 5 meters with an error margin of ±2 meters.

[S 1- 4] Each tag will transmit a unique digital ID code to a receiver.

[S 1- 5] High sensitivity of 10^{-5} BER (Bit Error Rate) in transmission), assuming no interference

[S 1- 6] The transmitters will have an on/off switch

[S 1- 7] The tag will be able to operate in a temperature range of 0ºC to 70ºC

[S 1- 8] The tag will operate in a relative humidity range of 10-90%

[S 1- 9] The tag will typically operate in a 1 atmosphere environment

[S 1- 10] The tag will be able to transmit in all directions

[S 1- 11] The tag will be able to transmit through materials permeable to radio waves

3.3. Power and Voltage Consumption

If we utilize an active transmitter, we need to specify how much power the transmitter will utilize in order to determine how often the battery must be replaced.

[S 1- 12] The tag will be able to transmit continuously for a period of at least 90 days[1]

[S 1- 13] The tag will utilize a maximum of 5.0 Watts

[S 1- 14] The tag will have a user replaceable power source.

[1] 1 day will be considered 8 hours of continuous transmission.

4. Receiver Unit

4.1. Physical Requirements

We hope to achieve a receiver design whose size and weight is not uncomfortable and inconvenient. The following figure illustrates a potential design for the receiver.

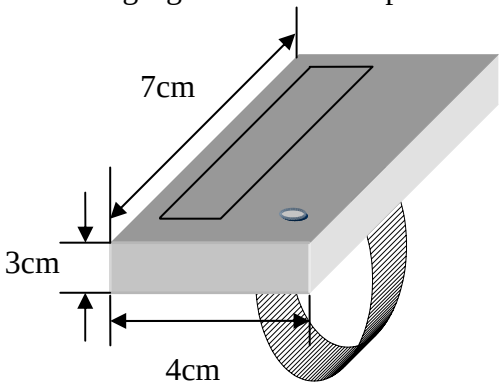

Figure 5: Potential Receiver Shape and Dimensions (Not to scale)

[S 1- 15] The receiver will have an LCD display for feedback
[S 1- 16] The receiver will have a buzzer for audible feedback
[S 1- 17] The receiver will have a 5-way switch or multiple buttons for input
[S 1- 18] The weight of the receiver with a battery will be at a maximum, 300 grams
[S 1- 19] The receiver will have an on/off switch
[S 2- 5] The tag will have maximum dimensions of 7cm x 4cm x 3cm
[S 2- 6] The receiver will have a casing that encloses all circuitry
[S 2- 7] The receiver will have a wrist strap or ring of some form enabling it to be worn as a watch or attached to keys like a key fob.

4.2. Performance Requirements

[S 1- 20] According to Industry Canada RSS-210 §5.12, our device must meet the following requirements:

"Operation is subject to the following two conditions: (1) this device may not cause interference, and (2) this device must accept any interference, including interference that may cause undesired operation of the device."

[S 1- 21] The receiver will have a range of approximately 5±2 meters
[S 1- 22] The receiver will be able to identify the transmitted unique tag ID
[S 1- 23] Users will be able to assign names to identify tags attached to specific items
[S 1- 24] The receiver will operate in a temperature range of 0ºC to 70ºC
[S 1- 25] The tag will operate in a relative humidity range of 10-90%

[S 1- 26] The tag will typically operate in a 1 atmosphere environment

[S 1- 27] High sensitivity of 10^{-5} BER (Bit Error Rate), assuming no interference

[S 1- 28] The receiver will have a response time to transmissions of less than or equal to 12 ms.

[S 1- 29] The receiver will be able to handle up to five different tags at once

[S 1- 30] The receiver will be able to receiver transmissions from all directions

[S 1- 31] The receiver will be able to receive transmissions through materials permeable to radio waves

4.3. Power and Voltage Consumption

We need to specify how much power the receiver will consume in order to determine how often the battery must be replaced.

[S 1- 32] The receiver will not require a change in battery for at least 3 months under normal usage[2]

[S 1- 33] The receiver will have a replaceable power source

[S 1- 34] The tag will utilize a maximum of 5.0 Watts

5. Situational Requirements

In order to ensure the robustness of our system, we specify certain situations which our system must be capable of handling.

[S 2- 8] **Situation 1: The user leaves behind more than one object at once.**
The receiver will inform the user when more than one object has been forgotten, using either a visual or auditory indicator, or both.

[S 2- 9] **Situation 2: The user is in range of another person with the same device.**
Tag devices which have unique ID's will be uniquely identifiable so multiple users of SafeGuard devices and tags can operate normally in close proximity (less than 5 meters) of each other. Up to 20 people with unique tag IDs may be within range of each other, and the SafeGuard devices will continue to operate normally.

[S 2- 10] **Situation 3: The user wished to leave tagged devices behind temporarily for less than 5 minutes, without having an alarm sound.**
The SafeGuard will allow the user to temporarily deactivate the warning system for 5 minutes.

[2] Normal use is defined as being activated for 8hrs/day and having an alarm sound once per day for a maximum time of 5 seconds. Additionally, the display will only be active for 10 minutes per day in total.

[S 2- 11] **Situation 4: The user is at home or places where tracking is no longer required.**
The user will be able to turn off both SafeGuard devices and tags permanently.

[S 2- 12] **Situation 5: The system is utilized in an area where other devices are utilizing the same frequency range as the system.**
To comply with Industry Canada licensing for LPDs, SafeGuard devices and tags must accept interference which causes undesired operation.

6. Reliability and Durability

We further specify the durability and reliability of our system in certain conditions.

[S 2- 13] The receiver and tags should be able to withstand a drop from a maximum height of 1 meter onto a carpeted surface.

[S 2- 14] The tags and receivers should continue normal operation as specified in §3.3 and §4.3 when the power source specified by Mnemosyne Technologies is used. However, if the user replaces the power source with one which is not specified then normal operational lifetime may be shorter than specified in §3.3 and §4.3.

[S 3- 1] If the devices are operated normally (not abused), and when batteries are replaced as required, the SmartGueard devices and tags should operate normally for a period of one year, but are expected to function much longer.

7. Regulatory and Safety Standards

Due to the nature of our product our product must satisfy certain standards. There are several general standards dealing with electronics and RF transmission which must be met.

[S 1- 35] The system will adhere to either Industry Canada standards for unlicensed RF devices or Federal Communications Commission (FCC) standards Part 15 for unlicensed RF devices. However, the SafeGuard system will not be certified by either Industry Canada or the FCC, as certification requires equipment and funding which are presently beyond the financial capabilities of Mnemosyne Technologies.

[S 1- 36] The SafeGuard system may adhere to CSA Standards, however due to financial constrains, CSA standards are not available to Mnemosyne Technologies; therefore it may be impossible to adhere to CSA standards.

8. Limitations:

[S 1- 37] Each receiver will be able to track a maximum of 5 items
[S 1- 38] The system or system components will not operate in a region where RF cannot permeate the area
[S 1- 39] Users cannot add tags which were not originally assigned to the receiver

9. Potential Functions / Abilities

[S 3- 2] The receiver will have a “low battery” indicator to indicate when the tags are running low on power
[S 3- 3] The receiver will be able to change the distance at which the receiver activates
[S 3- 4] The user may enter a time (besides the default 5 minute time) for temporarily disabling the alarm function

10. Conclusion:

People lose items everyday. Lost and founds are everywhere you go; each is filled with items that people never reclaim and often have to replace at significant cost. As the market penetration of cell phones, pocket PCs, and other small electronic equipment increases, the number of items which are lost also increases. The SafeGuard provides a solution for the forgetful and absentminded, preventing the loss of their items. The goal of Mnemosyne Technologies is to generate a product with all the preceding specifications by the end of April. Based on the functional specifications for the SafeGuard, Mnemosyne Technologies believes that creating such a functional prototype is well within its capabilities.

11. References

Gubisch, Roland W., “Inside FCC Part 15 and Canada's Corresponding Standards” , <http://www.ce-mag.com/99ARG/Gubish31.html>, February, 2005

Industry Canada, “Low Power Licence-Exempt Radiocommunication Devices (All Frequency Bands)” [RSS-210], Issue 5, November 2001, <http://strategis.ic.gc.ca/spectrum> (English), <http://strategis,ic.gc.ca/spectre> (French)