**System Test Plan**

**For**

**NASA Vestibular Chair**

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# Introduction

## Purpose

This document is a test plan for NASA Vestibular Chair System Testing, produced by the System Testing team. It describes the testing strategy and approach to testing the team will use to verify that the application meets the established requirements of the product owner.

## Objectives

* Meets the requirements, and specifications set by the product owner.
* Satisfies the needed safety requirements.
* Performs within expected measures with little error.

# Functional Scope

The Modules in the scope of testing for the NASA Vestibular Chair System Testing are mentioned in the document attached in the following path:

1. The System Requirements Specification document:   
   <https://github.com/prowl107/NASA-Vestibular-Chair/blob/54404698a9813828192d3e3bc8d47806a4e6bff6/Documentation/SRS/SRS%20V1.md>
2. Section 3.1 of this document
3. Standard Operating Procedures for Proctors and Operators
   1. NOTE: This document is planned to be included with the system. Upon completion of its official release, a link will be provided here.

# Overall Strategy and Approach

## Testing Strategy

The NASA Vestibular Chair testing strategy will include testing the functionality of all items included in section 2. Tested items include the following:

1. Transmitting commands to the motor controller to test the functionality of the chair in relation to its rotational speed.
2. Mechanical kill switch operation to ensure power delivery is immediately suspended
3. Soft switches to ensure chair slows down gradually but not abruptly causing damage to the patient
4. Nominal test sequence to raise the motor to a speed within 100 degrees per second and allow the chair to free coast down to an idle state
5. Bi-directional input (i.e., joystick) to allow the user to indicate perceived spin direction

### Function Testing

Test Objective: Ensure the controller module is able to properly provide power to the chair, as well as stop it with its kill switch. This includes both the soft switches and the mechanical kill switch

**Technique**:

#### **Mechanical Hard/Kill Switch Testing:**

* 1. Wire the controller module to the vestibular chair and initiate a sequence that will provide voltage to rotate the chair
  2. During the test, press/depress the mechanical hard kill switch and measure the input voltage on the chair’s power terminals
  3. Observe the motor behavior of the chair to ensure it is in a free coast state.

#### **Soft Switch Testing:**

1. Wire the controller module to the vestibular chair and initiate a sequence that will provide voltage to rotate the chair
2. During the test, press/depress the one of the soft kill switches and measure the input voltage on the chair’s power terminals.
3. Observe the motor behavior of the chair to ensure that it reaches 0 rpm in the specified amount of time.

**Completion Criteria**: In all test cases the controller can provide power to the chair to have it move, and the kill switch is able to kill power to the chair and or bring it to an idle state.

### Data Testing

Test Objective: Ensure the data that is collected is collected properly, able to be exported in the correct format, and displayable.

**Technique**:

1. Use the Nucleo development board to store and display program data to the seven segment displays
2. Use a STM32 development board to store and transmit the data taken from the tachometer, accelerometer and joystick to the web interface

**Completion Criteria:** In all test cases, the proper data collection is displayed, and all measured values are accurate.

### Performance Testing

**Test Objective**: Ensure the chair is able to ramp up to the specified RPM, coast, and then lower its speed until it stops moving.

**Technique:** Write test cases using the controller that specify the RPM value and measure with a tachometer to determine if the chair is spinning at the correct speed.

**Completion Criteria:** In all test cases, the chair reaches the RPM set through the controller and manages to coast to a stop.

## System Testing Entrance Criteria

In order to start system testing, the testing readiness can be classified under usability testing, functional testing, and data testing.

## Testing Types

### Usability Testing

The user interface will be tested for ease of use as well as how accurate it is able to perform the actions specified by the user with relation to the controller itself as well as the Vestibular chair. This is done through testing of the controller, as it is the focal point of user interaction with the rest of the system.

System Requirements Specification**,** SYS-4**:** “The system shall have two "soft" kill switches that will allow the chair to "free coast" down to 0 rpm”

System Requirements Specification, SYS-5:” The system shall have a "hard" mechanical kill switch that will disable power delivery to the chair

System Requirements Specification, SYS-21:”The system shall support user input from a bi-directional control interface.”

System Requirements Specification, SYS-26:” The proctor shall only be able to actuate the chair or start a test after a unique button/switch is pressed (arming switch)

System Requirements Specification**,** SYS-28:” The web interface shall allow the operator to add different test sequences.”

System Requirements Specification**,** SYS-33**:”** The web interface shall display stored test sequences from a dropdown menu.”

### Data Testing

The data will be tested for correctness of measurement based on known inputs, as well as its ability to display properly on the display that will be a part of the controller.

System Requirements Specification**,** SYS-9**:”** The system shall record chairs current position (steady state).”

System Requirements Specification, SYS-10:” The system shall record the desired rpm set by the proctor.”

System Requirements Specification**,** SYS-11**:”** The system shall record the rpm that the chair is currently spinning at.”

System Requirements Specification, SYS-12: “The system shall record the time elapsed during the current test sequence.”

System Requirements Specification**,** SYS-13:”When the user indicates via the bi-directional control method, the system shall record the total time the user indicates they are spinning.”

System Requirements Specification**,** SYS-14:” When the user indicates via the bi-directional control method, the system shall record the direction they think they are spinning in.”

System Requirements Specification**,** SYS-17:” The system shall record acceleration data.”

System Requirements Specification**,** SYS-18:” The system shall record tachometer data.”

System Requirements Specification, SYS-19:” The system shall record the current direction of the chair”

### Functional Testing

The functionality of the device will be tested for the chair’s ability to function correctly as intended and indicated by the user. This includes its ability to spin in the correct direction, the speed at which the chair rotates, the controller’s ability to function properly in relation to data collection and its ability to provide correct instructions to the functionality of the chair such as setting its speed and direction of rotation.

System Requirements Specification**,** SYS-1**:”** The system shall allow the chair to spin up to a specified RPM determined by the proctor”.

System Requirements Specification**,** SYS-2**:”** After a specified duration set by the operator/proctor, the chair should enter a free coast state.”

System Requirements Specification**,** SYS-8**:”** The system shall not exceed 100 degrees per second (1 revolution every 3 seconds) at any point during its operation.”

System Requirements Specification**,** SYS-24**:”** The system must interface with a wireless bi-directional controller such as a joystick or button.”

## Suspension Criteria and Resumption Requirements

This section will specify the criteria that will be used to suspend all or a portion of the testing activities on the items associated with this test plan.

### Suspension Criteria

* If the controller causes too large of an output of power to the chair resulting in the motor spinning higher than the specified limit of 100 degrees per second.
* If the mechanical kill switch fails to cut power to the chair while it rotates.

### Resumption Requirements

Resumption of testing will occur when the mechanical kill switch is wired to correctly kill the power, or when an additional switch is used to perform the same function given a malfunction of the initial switch.

### 

# Execution Plan

## Execution Plan

The test plan for the NASA Vestibular Chair is as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Requirement (From SRS) | Test Case Identifier | Input | Expected Behavior | Pass / Fail |
| SYS-1: The system shall allow the chair to spin up to a specified RPM determined by the proctor | 1.1 | The proctor inputs specified RPM for the chair to spin at. | The chair spins at the RPM determined by the proctor without much deviation. |  |
| SYS-4**:** The system shall have a "soft" kill switch that will allow the chair to "free coast" down to 0 rpm. | 2.1 | The proctor presses the soft kill switch present in the software. | The chair will slow to a stop faster than it would if the speed was manually turned down. |  |
| SYS-5**:** The system shall have a mechanical kill switch that will bring the chair to stop faster than the soft switch. | 3.1 | The proctor presses the mechanical kill switch on the controller. | The chair will slow to a stop faster than the soft kill switch. |  |
| SYS-9: The system shall record chairs current position (steady state). | 4.1 |  | The chair’s rotational position will be output to the proctor. |  |
| SYS-11: The system shall record the rpm that the chair is currently spinning at. | 5.1 | Tachometer readings transmitted to the controller. | The chair’s rotational speed will be output to the proctor. |  |
| SYS-15: When the user indicates via the bi-directional control method, the system shall record timestamps of when the button is triggered | 6.1 | The patient moves the joystick in a left or right direction. | The joystick reading will be output to the proctor indicating when it is used. |  |
| SYS-21: The system shall support user input from a bi-directional control interface | 7.1 | Presence of a joystick that interfaces with the controller. | The joystick transmits to the controller properly. |  |
| SYS-26: The proctor shall only be able to actuate the chair or start a test after a unique button/switch is pressed (arming switch) | 8.1 | Proctor utilizes interface to select a test sequence or input parameters. | The chair will begin moving according to the parameters set by the proctor. |  |
| SYS-24**:** The system must interface with a wireless bi-directional controller such as a joystick or button. | 9.1 | Presence of a joystick that interfaces with the controller. | The joystick interfaces with the controller correctly. |  |
| SYS-28: The web interface shall allow the operator to add different test sequences | 10.1 | Proctor inputs parameters into web interface. | Different test sequences are stored in the web interface. |  |
| SYS-30: The web interface shall feature a unique button to select the test sequence | 11.1 | Proctor selects saved test sequence. | The selected test sequence is loaded properly. |  |

# Traceability Matrix & Defect Tracking

## Traceability Matrix

List of requirements, corresponding test cases

***Requirement* CRITICAL**: System Requirements Specification**,** SYS-1: “The system shall allow the chair to spin up to a specified RPM determined by the proctor.”

***Test Cases****:* Check for accurate RPM of the chair with a tachometer compared to proctor set value.

***Requirement* CRITICAL**: System Requirements Specification**, S**YS-4**: “**The system shall have a "soft" kill switch that will allow the chair to "free coast" down to 0 rpm.”

***Test Cases****:* Check that the kill switch cuts power to the chair and lets it free spin.

***Requirement* CRITICAL**: System Requirements Specification**,** SYS-5**:** “The system shall have a mechanical kill switch that will bring the chair to stop faster than the soft switch.”

***Test Cases****:* Check that the kill switch cuts power to the chair immediately.

***Requirement* MEDIUM**: System Requirements Specification**,** SYS-9: “The system shall record chair’s current position (steady state).”

***Test Cases****:* Check that the sensors correctly measure the chair’s position.

***Requirement* MEDIUM**: System Requirements Specification**,** SYS-11: “The system shall record the rpm that the chair is currently spinning at.”

***Test Cases****:* Check for RPM measurement output using tachometer.

***Requirement* MEDIUM**: System Requirements Specification**,** SYS-15: “When the user indicates via the bi-directional control method, the system shall record timestamps of when the button is triggered.”

***Test Cases****:* Check that joystick transmits properly to controller.

***Requirement* CRITICAL**: System Requirements Specification**,** SYS-21: “The system shall support user input from a bi-directional control interface.”

***Test Cases****:*

***Requirement* CRITICAL**: System Requirements Specification**,** SYS-24**:** “The system must interface with a wireless bi-directional controller such as a joystick or button.”

***Test Cases****:*

***Requirement* MEDIUM**: System Requirements Specification**,** SYS-28: “The web interface shall allow the operator to add different test sequences.”

***Test Cases****:* Check that the operator is allowed to utilize multiple test cases.

***Requirement* MEDIUM**: System Requirements Specification**,** SYS-30: “The web interface shall feature a unique button to select the test sequence.”

***Test Cases****:* Check that the software defined button will connect to the correct sequence.

## Defect Severity Definitions

|  |  |
| --- | --- |
| **Critical** | The defect causes a catastrophic or severe error that results in major problems and the functionality rendered is unavailable to the user. A manual procedure cannot be either implemented or a high effort is required to remedy the defect. Examples of a critical defect are as follows:   * System abends * RPM limit is exceeded * Data is corrupted or cannot post to the database |
| **Medium** | The defect does not seriously impair system function can be categorized as a medium Defect. A manual procedure requiring medium effort can be implemented to remedy the defect. Examples of a medium defect are as follows:   * Form navigation is incorrect * Field labels are not consistent with global terminology |
| **Low** | The defect is cosmetic or has little to no impact on system functionality. A manual procedure requiring low effort can be implemented to remedy the defect. Examples of a low defect are as follows:   * Repositioning of fields on screens * Text font on reports is incorrect |

# Environment

## Environment

* In order to conduct the testing, the tester needs to have the following:
  1. Access to the NASA Vestibular chair
  2. Access to the controller of the chair
  3. Access to the selected power supply or equivalent

# Assumptions

This section details specific assumptions that are made throughout the project

* There is no individual sitting in the NASA Vestibular Chair
* The power supply connected to the controller and chair does not output higher than 24V

# Risks and Contingencies

Some risks involved with testing the NASA Vestibular Chair involve the possibility of spinning the chair too fast. This consideration is made because if the controller supplies to high of a voltage, the chair could risk falling over or hurting the individual sitting in it. The contingency in place to prevent this is code built into the controller to prevent the voltage from being supplied at a value that would cause the rotational speed of the chair to exceed 100 degrees per second, as well as a mechanical kill switch that will be built into the controller to shut off power to the chair if it begins to spin too fast.

Another potential risk involved with the testing comes in the form of loss of information between the controller and analog components of the chair. Since the components within the NASA Vestibular Chair are mostly analog, there is a chance of loss of data between the components present in the internal hardware and those in the controller. A contingency for this is the inclusion of digital components within the controller, to have two forms of communication with the internal hardware of the chair as a backup in case one fails.

|  |  |  |  |
| --- | --- | --- | --- |
| Risk # | Risk | Impact | Contingency |
| 1 | Chair Spins too Fast | High | Code built into the controller to prevent the voltage from being supplied at a value that would cause the rotational speed of the chair to exceed 100 degrees per second, as well as a mechanical kill switch that will be built into the controller to shut off power to the chair if it begins to spin too fast |
| 2 | Information loss between controller and chair | High | Inclusion of digital components within the controller, to have two forms of communication with the internal hardware of the chair as a backup in case one fails |

# Appendices

*None currently available*

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