Title: ,

*“A Project”*

Prepared by Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

,

Checked by Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

, Health and Safety Officer

Approved by Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Michael Hamilton, Student Manager 2010

Authorised for use by Date \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Dr Luis Mejias, Project Coordinator

**QUT Avionics**

Queensland University of Technology

CRCSS-EESE, GPO Box 2434

Gardens Point Campus

Brisbane, Australia, 4001.

Telephone (+61 7) 3864 1772

Facsimile (+61 7) 3864 1517

e-mail luis.mejias@qut.edu.au

web <http://code.google.com/p/ahns10/>

This document is Copyright 2010 by the QUT. The content of this document, except that information which is in the public domain, is the proprietary property of the QUT and shall not be disclosed or reproduced in part or in whole other than for the purpose for which it has been prepared without the express permission of the QUT

**Revision Record**

|  |  |  |  |
| --- | --- | --- | --- |
| Document Issue/Revision Status | **Description of Change** | **Date** | **Approved** |
|  | Initial Issue |  |  |

**Distribution List**

|  |  |  |  |
| --- | --- | --- | --- |
| **Name** | **Affiliation** | **Distribution Date** | **Approved** |
| Avionics Lab File Archive | QUT Avionics |  |  |

**Foreword**

A risk management plan is essential for any project that will be operating around risks that could pose damage to group members, the general public, budget constraints, timeline constraints and project components. This document will outline the identified risks for the 2010 AHNS project, determine the severity of the risk, outline the procedures to mitigate the risk, and analyse the new risk rating.

**Table of Contents**

Paragraph Page No.

[1 Introduction 8](#_Toc264986091)

[1.1 Scope 8](#_Toc264986092)

[1.2 Background 8](#_Toc264986093)

[2 Reference Documents 9](#_Toc264986094)

[2.1 QUT Avionics Documents 9](#_Toc264986095)

[2.2 Non-QUT Documents 9](#_Toc264986096)

[3 Risk Management 10](#_Toc264986097)

[3.1 Context 10](#_Toc264986098)

[3.2 Objective 10](#_Toc264986099)

[3.3 Risk Categories 10](#_Toc264986100)

[3.3.1 Personal Injury 11](#_Toc264986101)

[3.3.2 Property Damage 11](#_Toc264986102)

[3.3.3 Schedule 11](#_Toc264986103)

[3.3.4 Technical 11](#_Toc264986104)

[3.3.5 Budgetary 11](#_Toc264986105)

[4 Risk Mitigation 13](#_Toc264986106)

[4.1 Risk Identification Methodology 13](#_Toc264986107)

[4.1.1 Brainstorming and Role Play 13](#_Toc264986108)

[4.1.2 Practical Experience 13](#_Toc264986109)

[4.2 Risk Analysis and Control Plan 13](#_Toc264986110)

[4.2.1 Likelihood 13](#_Toc264986111)

[4.2.2 Consequence 14](#_Toc264986112)

[4.2.3 Risk Rating 15](#_Toc264986113)

[4.2.4 Controls 15](#_Toc264986114)

[4.3 Monitor and Review Plan 16](#_Toc264986115)

[4.3.1 Periodic Review 16](#_Toc264986116)

[4.3.2 Review and Acceptance of New Risks 16](#_Toc264986117)

[5 Risk Acceptance Responsibility 17](#_Toc264986118)

[5.1 Personal Injury 17](#_Toc264986119)

[5.2 Schedule 17](#_Toc264986120)

[5.3 Technical 17](#_Toc264986121)

[5.4 Budgetary 18](#_Toc264986122)

[6 Conclusion 19](#_Toc264986123)

[7 Recommendations 20](#_Toc264986124)

[8 Appendices 21](#_Toc264986125)

**List of Figures**

Figure Page No.

No Figures.

**List of Tables**

Table Page No.

[Table 1: Risk Evaluation Table 15](#_Toc261090029)

[Table 2 - Risk Levels 15](#_Toc261090030)

[Table 3: Control Measure Risk Reduction 16](#_Toc261090031)

[Table 4- Control Measure Effectiveness 16](#_Toc261090032)

[Table 5: Personal Injury Risk Acceptance Responsibility 17](#_Toc261090033)

[Table 6: Schedule Risk Acceptance Responsibility 17](#_Toc261090034)

[Table 7: Technical Risk Acceptance Responsibility 17](#_Toc261090035)

[Table 8: Budgetary Risk Acceptance Responsibility 18](#_Toc261090036)

**Definitions**

|  |  |
| --- | --- |
| QUT | Queensland University of Technology |
| AHNS | Autonomous Helicopter Navigation System |
| HLO | High Level Objective |
| SR | System Requirement |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |
|  |  |

# Introduction

This document outlines the Risk Management Plan developed for the 2010 Autonomous Helicopter Navigation System project. A risk management plan identifies the risks that could potentially effect personal and project objectives. These risks are then pro-actively managed to ensure the safety, health and wellbeing of all staff, students and general public that interact with the project. A detailed risk management document is essential for any project under the jurisdiction of QUT.

## Scope

This document details the risks and prevention methods for mitigating the damage on personal, equipment and project goals. This document will be restricted to the Risk Management Plan for the 2010 AHNS project.

## Background

This document has been written as part of the Project Management Plan RD/1, which overviews how the AHNS’s HLO’s and SR’s will be completed within the specified time frame, financial budget, and safety guidelines.

# Reference Documents

## QUT Avionics Documents

|  |  |  |
| --- | --- | --- |
| RD/1 | AHNS-2010-SY-PM-001 | AHNS, Project Management Plan of |

## Non-QUT Documents

|  |  |  |
| --- | --- | --- |
| RD/2 | SP-601S | NASA Systems Engineering Handbook |

In the event of any conflict between this document and any RD referenced herein, such conflict shall be notified to .

In the following text, RD/x identifies referenced documents, where "x" denotes the actual document.

# Risk Management

The following section details the risk management procedure for the 2010 AHNS project. The purpose of the plan is to ensure that any incident with potential to harm a team member or delay in progress of the project can be successfully avoided or appropriately handled by following a detailed mitigation procedure. Risk management is an important consideration for any system engineering process. It is standard to categorise risks into several groups, which are formulated from RD/2.

The risk management process involves:

* Determine responsibilities and context of the project.
* Indentify hazards within the project.
* Assess the risks existing in each hazard.
* Determine control measures.
* Implement control measures.
* Review effectiveness of control measures.

This document forms an important part of the communication and consultation process.

## Context

This Risk Management Plan shall be used by the project manager, team members and supervisors of the AHNS 2010 project to manage the risks associated with all stages of the project.

## Objective

The objective of the Risk Management Plan is to ensure that QUT and persons associated with the AHNS 2009 project are aware of and understand the risks presented by the development and operation of the project, and that no unnecessary risks are undertaken, which do not have a corresponding opportunity or benefit.

## Risk Categories

The following sections detail the risks involved within five categories for the AHNS projects lifecycle.

* Personal Injury
* Property Damage
* Schedule
* Technical
* Budgetary

### Personal Injury

This plan manages the risks related to personal injury of team members, visitors and the general public including;

* Health and Safety risks to the extent to which the operations of the project can impact on group members, visitors and the general public.
* The risks associated with the use of construction and development tools and equipment.
* Personal injury associated with attending testing and demonstrations sites external to the university.

### Property Damage

This plan manages the risks associated with damage to the property of the AHNS group and also any property owned by QUT, such as:

* Damage to or loss of the AHNS Helicopter Platform
* Damage to QUT facilities, or external testing sites.
* Damage to construction or development tools.

### Schedule

This plan manages the schedule related risks to the AHNS 2010 project including;

* Failure to achieve objectives or system requirements of the project.
* The delivery of purchased parts or equipment.
* Student commitments to other subjects and external activities.

### Technical

The plan manages the technical risks to the AHNS 2010 project including;

* Damage to/loss of helicopter platform.
* Failure during development or flight testing of subsystems.
* Errors in design/planning.
* Inexperience of team members.

### Budgetary

This plan manages the financial risks to the AHNS 2010 project including;

* Expenditure due to damaged parts.
* Expenditure due to collateral damage.
* Financial impacts as a result of non-compliance with laws or regulations.

# Risk Mitigation

Once risks for the AHNS project are identified, mitigation procedures must be developed in order to minimise potential hazards. Following this risk mitigation procedure will aid in reducing any potential hazard to the safety of individuals, equipment, and the surrounding environment. The following sections detail potential hazards and their mitigation procedures.

## Risk Identification Methodology

The following spread of strategies is being applied to assist in Risk Identification.

### Brainstorming and Role Play

Brainstorming and role play is a major source or risk identification. This approach essentially involves round table discussions with the AHNS team members and supervisors in order to run through scenarios. This process results in the identification of many hazards which will occur during the development and operation of the project.

### Practical Experience

AHNS personnel have some background experience in their respective subsystems. This experience is important in identifying hazards and risks. Cases where there is a lack of expertise among the team members, experts on the particular subject will be actively approached to provide support and insight.

## Risk Analysis and Control Plan

Guidance for risk analysis and control has been sought from a number of sources and a tailored risk analysis methodology is presented here.

### Likelihood

#### Almost Certain

An event which could be expected to occur multiple times throughout the life of the program.

#### Likely

An event which could be expected to occur a few times throughout the life of the program.

#### Moderate

An event which could be expected to occur once or twice throughout the life of the program.

#### Unlikely

An event which could occur, but is not expected to occur throughout the life of the program.

#### Rare

An event which is not expected to occur during the program;

### Consequence

#### Insignificant

No injuries, low financial implications

#### Minor

Possible injuries requiring no more than first aid treatment, medium financial loss.

#### Moderate

Possible injuries would require medical treatment, high financial loss.

#### Major

Extensive injuries possible, major financial loss.

#### Catastrophic

Death is clearly possible, huge financial implications.

### Risk Rating

The matrix defined Table 1: Risk Evaluation Table is used to evaluate the Risk Rating based on the likelihood and consequence assessments.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Likelihood** | **Consequences** | | | | |
| **Insignificant** | **Minor** | **Moderate** | **Major** | **Catastrophic** |
| **Almost Certain** | Moderate | High | Extreme | Extreme | Extreme |
| **Likely** | Moderate | High | High | Extreme | Extreme |
| **Moderate** | Low | Moderate | High | Extreme | Extreme |
| **Unlikely** | Low | Low | Moderate | High | Extreme |
| **Rare** | Low | Low | Moderate | High | High |

Table : Risk Evaluation Table

The following provides guidance on the required actions based on the risk rating.

zTable - Risk Levels

|  |  |
| --- | --- |
| **Risk Levels** |  |
| 1. Immediate Action Required. Do not proceed with activity | Extreme |
| 2. Senior management attention required. | High |
| 3. Proceed with caution. | Moderate Risk |
| 4. Manage by routine procedures. | Low Risk |

### Controls

Each identified risk should have controls applied to ensure that they do not occur. Table 4 and Table 3 provide guidance on how to prioritise and assess the effectiveness of the proposed controls, and how they affect the residual risk.

Note that residual risk can also be assessed by re-assessing the likelihood and consequence of the adverse event occurring, given the proposed controls; however this does not always yield a true picture of the residual risk. The tables below provide guidance on the preferred types of controls to use in such situations.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Control Measure Effectiveness** | | |  |  | |
|  | **Extreme** | **High** | **Moderate** | | **Low** |
| **Excellent** | Low | Low | Low | | Low |
| **Good** | Moderate | Low | Low | | Low |
| **Fair** | High | Moderate | Low | | Low |
| **Poor** | Extreme | High | Moderate | | Low |

Table : Control Measure Risk Reduction

|  |  |
| --- | --- |
| **Control measures** |  |
| 1. Eliminate (Best Solution – Eliminate the Risk) | Excellent |
| 2. Substitute (Replace for a less hazardous outcome) | Excellent |
| 3. Engineer (Re-design or modify to lower risk) | Good |
| 4. Isolate (Remove process or operation to a safer location) | Fair |
| 5. Administrate (Create procedural instructions) | Poor |
| 6. Personal Protective Equipment (Last choice) | Poor |

Table - Control Measure Effectiveness

## Monitor and Review Plan

### Periodic Review

A Periodic Review of the Risk Management Plan and Hazard Log shall be carried out each semester. Review results shall be forwarded to the supervisor for review and acceptance. Significant changes will be explicitly identified in the report.

### Review and Acceptance of New Risks

Newly identified hazards shall be added to the hazard log. The individual carrying out the new risk assessment shall identify any conflicts with existing risks.

# Risk Acceptance Responsibility

Risk acceptance must consider the benefits and opportunities presented as well as the risk rating when considering if a given risk should be accepted.

## Personal Injury

|  |  |  |
| --- | --- | --- |
| **Residual Risk** | **Acceptance Criteria** | **Acceptance Responsibility** |
| High | Not Acceptable | NA |
| Medium | Acceptable with review of supervisor. | Project Manager |
| Low | Acceptable with normal review. | Project Manager |

Table : Personal Injury Risk Acceptance Responsibility

## Schedule

|  |  |  |
| --- | --- | --- |
| **Residual Risk** | **Acceptance Criteria** | **Acceptance Responsibility** |
| High | Not Acceptable | NA |
| Medium | Acceptable with review of supervisor. | Project Manager |
| Low | Acceptable with normal review. | Project Manager |

Table : Schedule Risk Acceptance Responsibility

## Technical

|  |  |  |
| --- | --- | --- |
| **Residual Risk** | **Acceptance Criteria** | **Acceptance Responsibility** |
| Extreme | Not Acceptable | NA |
| High | Not Acceptable | NA |
| Moderate | Acceptable with review of supervisor | Project Manager |
| Low | Acceptable with normal review. | Project Manager |

Table : Technical Risk Acceptance Responsibility

## Budgetary

|  |  |  |
| --- | --- | --- |
| **Residual Risk** | **Acceptance Criteria** | **Acceptance Responsibility** |
| High | Not Acceptable | NA |
| Medium | Acceptable with review of supervisor. | Project Manager |
| Low | Acceptable with normal review. | Project Manager |

Table : Budgetary Risk Acceptance Responsibility

# Conclusion

In conclusion, all measure must be in place to ensure that the risk that poses team members, surrounding students, general public, budget, timeline and property damage are mitigated. This will ensure safe working conditions for the project to operate in, while supplying peace of mind for timeline and financial budgets. It is recommended that this risk management plan is followed, and that any unidentified risks are brought to the project members attention.

# Appendices

The following appendices form part of this document.

1. Appendix A – Risk Hazard Log
2. Appendix B – QUT Risk Management Form

**AHNS 2010** **Risk Hazard Log**

Table of Content

Platform Accident23

Cuts/Abrasions24

Burns25

Electrical26

Arrival of Equipment27

Personal Availability28

Failure to achieve HLOs 29

Software Environment Training30

Student Workload31

Resource Availability32

Contribution of Team Members33

Damage to/loss of helicopter hardware34

Failure of Communication Hardware35

Failure of Control Software36

Failure of State Estimation Software37

Failure of Vision System38

Failure of VICON System39

Inability of Hardware to meet Performance Requirements40

Design and Planning Errors41

Student Inexperience42

Cost of Parts43

Damage to Helicopter and Onboard Equipment44

Technical Risks45

**Issue: 1st Revision**

**Date: .**

**HAZ – 1 – General Safety – Flight Testing**

**Platform Accident**

A platform accident could cause serious injuries to personnel. This pilot has undertaken extensive flight training, however there remains a risk that an accident could occur due to the nature of testing an autonomous system. The uncertainty related to switching to autonomous mode means that the risk of an accident is slightly elevated above that of manual indoor helicopter flight.

Effectiveness of Existing Controls: Fair

Likelihood: Unlikely

Consequence: Major

Risk rating: High

**Risk Treatment**

1. Aircraft operated by a suitably trained pilot;
2. Establish operational procedures based on sound risk assessment to minimise probability of accident;
3. Checklists of component condition and lifetime;
4. Regular aircraft maintenance to be carried out;

**Risk Treatment Type**

Engineering

Administration

**Residual Risk Assessment**

Effectiveness of proposed Controls: Good

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature:

**Issue: 1st Revision**

**Date: .**

**HAZ – 2 – General Safety – Personal Injury**

**Cuts/Abrasions**

AHNS team members will be required to operate mechanical equipment such as tools. These items can cause small cuts or abrasions if used improperly. Small cuts or abrasions to personnel in the team will hinder the project development and may cause up to a day’s loss.

Effectiveness of Existing Controls: Good

Likelihood: Moderate

Consequence: Minor

Risk rating: Moderate

**Risk Treatment**

1. Before using equipment, team members must ensure they are able to operate equipment safely;
2. First aid equipment will be present at all working areas;

**Risk Treatment Type**

Engineering

Administration

PPE

**Residual Risk Assessment**

Effectiveness of proposed Controls: Good

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature:

**Issue: 1st Revision**

**Date: .**

**HAZ – 3 – General Safety – Personal Injury**

**Burns**

AHNS team members may be exposed to the risks of small burns, either from equipment such as soldering irons or improperly handled batteries. Small burns to personnel in the team will hinder the project development and may cause up to a day’s loss.

Effectiveness of Existing Controls: Good

Likelihood: Unlikely

Consequence: Major

Risk rating: Low

**Risk Treatment**

1. Team members must have prior experience and be notified of the safe operation of soldering equipment and storage/use of batteries;
2. First aid equipment will be present at all working areas;

**Risk Treatment Type**

Engineering

Administration

PPE

**Residual Risk Assessment**

Effectiveness of proposed Controls: Good

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature:

**Issue: 1st Revision**

**Date: .**

**HAZ – 4 – General Safety – Personal Injury**

**Electrical**

AHNS team members may be exposed to the risks of small electric shocks from battery equipment or when using power tools. Small electric shocks to personnel in the team will hinder the project development and may cause time loss.

Effectiveness of Existing Controls: Good

Likelihood: Unlikely

Consequence: Minor

Risk rating: Low

**Risk Treatment**

1. The majority of the project will be completed within the QUT engineering laboratories; it is therefore a requirement that all members complete the safety induction;
2. First aid equipment will be present at all working areas;

**Risk Treatment Type**

Engineering

Administration

PPE

**Residual Risk Assessment**

Effectiveness of proposed Controls: Good

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature:

**Issue: 1st Revision**

**Date: .**

**HAZ – 5 – Schedule Risk – Time of Completion**

**Arrival of Equipment**

Equipment may be required to be imported from international/national destinations and may experience significant delays. Delays in the arrival of equipment will hinder the project development and may cause several weeks delay.

Effectiveness of Existing Controls: Nil

Likelihood: Moderate

Consequence: Moderate

Risk rating: High

**Risk Treatment**

1. Purchase product/parts locally and keep track of supplies;
2. Have replacement parts in the inventory;
3. Orders must be made promptly;

**Risk Treatment Type**

Substitution

Engineering

Administration

**Residual Risk Assessment**

Effectiveness of proposed Controls: Good

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature:

**Issue: 1st Revision**

**Date: .**

**HAZ – 6 – Schedule Risk – Time of Completion**

**Personal Availability**

AHNS team members and involved in a number of unit subjects and may not have full availability for the AHNS project at all times. Unavailability of AHNS personnel can hinder the project development and can cause delays.

Effectiveness of Existing Controls: Good

Likelihood: Moderate

Consequence: Minor

Risk rating: Moderate

**Risk Treatment**

1. Due to team members’ limited availability due to other commitments, permanent weekly meetings and workshops have been scheduled.

**Risk Treatment Type**

Administration

**Residual Risk Assessment**

Effectiveness of proposed Controls: Fair

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature:

**Issue: 1st Revision**

**Date: .**

**HAZ – 7 – Schedule Risk – Failure to Deliver**

**Failure to achieve HLOs**

A failure to achieve HLOs will negate the success of the AHNS project.

Effectiveness of Existing Controls: Fair

Likelihood: Unlikely

Consequence: Major

Risk rating: High

**Risk Treatment**

1. To ensure the project’s success, the team is to adhere strictly to the project schedule. If delays do occur, assistance is to be provided by the project manager and available team members.

**Risk Treatment Type**

Engineering

Administration

**Residual Risk Assessment**

Effectiveness of proposed Controls: Good

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature:

**Issue: 1st Revision**

**Date: .**

**HAZ – 8 – Schedule Risk – Learning Curve**

**Software Environment Training**

The programming environment for some sections of the project, exposed to the AHNS team is not familiar. The schedule for software programming may be underestimated. Not being able to produce essential software for the project by the AHNS personnel will hinder the progress for the project and may cause several weeks delay. If the software is vital to the HLOs, then the project may risk failure.

Effectiveness of Existing Controls: Good

Likelihood: Moderate

Consequence: Major

Risk rating: Extreme

**Risk Treatment**

1. Lost time is to be recovered with assistance of other experienced personnel (within and outside of the AHNS group).

**Risk Treatment Type**

Substitution

Engineering

Administration

**Residual Risk Assessment**

Effectiveness of proposed Controls: Excellent

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature:

**Issue: 1st Revision**

**Date: .**

**HAZ – 9 – Schedule Risk – Time of Completion**

**Student Workload**

As the AHNS team is also committed to a full time student workload, time must be shared amongst other academic commitments.

Effectiveness of Existing Controls: Good

Likelihood: Moderate

Consequence: Minor

Risk rating: Moderate

**Risk Treatment**

1. Group members are expected to complete 10 hours per week towards the project.

**Risk Treatment Type**

Administration

**Residual Risk Assessment**

Effectiveness of proposed Controls: Fair

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature:

**Issue: 1st Revision**

**Date: .**

**HAZ – 10 – Schedule Risk – Time of Completion**

**Resource Availability**

As some resources are shared between other QUAV projects the availability of resources for the project may be limited. Unavailability of resources for the use of AHNS personnel will hinder the project development and may cause several weeks loss.

Effectiveness of Existing Controls: Good

Likelihood: Moderate

Consequence: Insignificant

Risk rating: Low

**Risk Treatment**

1. AHNS members are to notify the relevant groups a minimum of one week prior to the use of resources and equipment;
2. If conflict occurs, the dispute will be discussed by the respective project managers.

**Risk Treatment Type**

Engineering

Administration

**Residual Risk Assessment**

Effectiveness of proposed Controls: Good

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature:

**Issue: 1st Revision**

**Date: .**

**HAZ – 11 – Schedule Risk – Time of Completion**

**Contribution of Team Members**

AHNS team members may not contribute equally to the project. Unequal contribution by AHNS team members will hinder project progress and may increase workloads for other team members.

Effectiveness of Existing Controls: Good

Likelihood: Moderate

Consequence: Insignificant

Risk rating: Low

**Risk Treatment**

1. Each team member is to be assignment a distinct responsibility. Identifying whether their work is being done will be easier;
2. If an issue arises it is to be brought to the attention of the team leaders immediately, and the group leader is to approach the offender and discuss possible solutions. Lost time will be made up with the assistance of the project manager and available team members.

**Risk Treatment Type**

Administration

**Residual Risk Assessment**

Effectiveness of proposed Controls: Fair

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature:

**Issue: 1st Revision**

**Date: .**

**HAZ – 12 – Technical Risk – Failure to Deliver**

**Damage to/loss off helicopter hardware**

The helicopter hardware forms the basis for the project. There is a risk of damage or complete loss of hardware in the event of UAV loss of control. Loss or damage of significant helicopter hardware may risk project failure if a replacement or repair is unavailable within scheduled time.

Effectiveness of Existing Controls: Fair

Likelihood: Unlikely

Consequence: Major

Risk rating: High

**Risk Treatment**

1. Depending on the particular hardware, significant time must be scheduled for replacement items.
2. On ordering international or national products, a replacement item should be ordered.
3. Schedule risks must be referred to.

**Risk Treatment Type**

Engineering

Administration

**Residual Risk Assessment**

Effectiveness of proposed Controls: Good

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature:

**Issue: 1st Revision**

**Date: .**

**HAZ – 13 – Technical Risk – Failure to Deliver**

**Failure of Communications Hardware**

The communications hardware is essential in development in developing a closed loop between the group station and the helicopter. Failure of the communication hardware will mean there is no down or up link between the ground station and the helicopter.

Effectiveness of Existing Controls: Good

Likelihood: Unlikely

Consequence: Major

Risk rating: High

**Risk Treatment**

1. The communications link must be schedule as a top priority and must begin development on the early stages of the project to ensure its full working completion.
2. Extensive testing must be done on the ground in order to ensure reliability of communication.

**Risk Treatment Type**

Engineering

**Residual Risk Assessment**

Effectiveness of proposed Controls: Good

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature:

**Issue: 1st Revision**

**Date: .**

**HAZ – 14 – Technical Risk – Failure to Deliver**

**Failure of Control Software**

The helicopter control software implements the algorithms needed to autonomously fly the helicopter.

Effectiveness of Existing Controls: Good

Likelihood: Unlikely

Consequence: Major

Risk rating: High

**Risk Treatment**

1. Commencement of the control system must be scheduled at an early stage of the project to ensure completion within the appropriate time.
2. Extensive testing of the helicopter control software must be scheduled for ground based prior to release of the software.

**Risk Treatment Type**

Engineering

**Residual Risk Assessment**

Effectiveness of proposed Controls: Good

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature:

**Issue: 1st Revision**

**Date: .**

**HAZ – 15 – Technical Risk – Failure to Deliver**

**Failure of State Estimation Software**

The state estimation software is a critical component of the AHNS project, combing the information received from external sensors to produce the system states. Failures of the state estimation software will directly influence the control software and may cause it to be unusable.

Effectiveness of Existing Controls: Good

Likelihood: Unlikely

Consequence: Major

Risk rating: High

**Risk Treatment**

1. Extensive testing of the state estimation software must be scheduled for ground based prior to the release of the software.

**Risk Treatment Type**

Engineering

**Residual Risk Assessment**

Effectiveness of proposed Controls: Good

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature:

**Issue: 1st Revision**

**Date: .**

**HAZ – 16 – Technical Risk – Failure to Deliver**

**Failure of Vision System**

The AHNS vision system will be primarily used to track shapes on the ground. Failure of the vision system could result in the helicopter moving to undesirable locations.

Effectiveness of Existing Controls: Good

Likelihood: Unlikely

Consequence: Major

Risk rating: High

**Risk Treatment**

1. Commencement of the vision system must be scheduled at an early stage of the project to ensure completion within the appropriate time.
2. Extensive testing must be completed on the ground prior to flight testing.

**Risk Treatment Type**

Engineering

**Residual Risk Assessment**

Effectiveness of proposed Controls: Good

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature:

**Issue: 1st Revision**

**Date: .**

**HAZ – 17 – Technical Risk – Failure to Deliver**

**Failure of VICON System**

The ARCAA VICON three dimensional tracking system will be implemented by the AHNS team for the use of localising the quad rotor helicopter. Failure of this device may result in a degrading result.

Effectiveness of Existing Controls: Fair

Likelihood: Unlikely

Consequence: Major

Risk rating: High

**Risk Treatment**

1. All members of the AHNS group will undergo VICON training to ensure that the system is used correctly.
2. Testing while not in flight will be taken.

**Risk Treatment Type**

Engineering

**Residual Risk Assessment**

Effectiveness of proposed Controls: Good

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature:

**Issue: 1st Revision**

**Date: .**

**HAZ – 18 – Technical Risk – Failure to Deliver**

**Inability of Hardware to meet Performance Requirements**

There are several components of the hardware and inadequate integration may cause a lack of performance. Failure of hardware to meet performance requirements may cause a degraded result. This will affect all HLOs and the overall project outcome.

Effectiveness of Existing Controls: Good

Likelihood: Unlikely

Consequence: Major

Risk rating: High

**Risk Treatment**

1. Detail design documents for the integration of hardware, and the accuracy and speed of the software must be produced.
2. Newer designs are to make sure problems of the last are taken into account and dealt with appropriately.

**Risk Treatment Type**

Engineering

Administration

**Residual Risk Assessment**

Effectiveness of proposed Controls: Good

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature:

**Issue: 1st Revision**

**Date: .**

**HAZ – 19 – Technical Risk – Time of Completion**

**Design and Planning Errors**

Unforeseen errors have the possibility to affect the outcomes of any project. Errors in planning or design of significant hardware or software may jeopardise the project failure if a corrected design or plan is unavailable within scheduled time.

Effectiveness of Existing Controls: Fair

Likelihood: Unlikely

Consequence: Major

Risk rating: High

**Risk Treatment**

1. All phases of the project have extra time allocated to allow for delays, and the entire project has extra time allocated after its completion before the due date to allow for delays.

**Risk Treatment Type**

Administration

**Residual Risk Assessment**

Effectiveness of proposed Controls: Good

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature:

**Issue: 1st Revision**

**Date: .**

**HAZ – 20 – Technical Risk – Time of Completion**

**Student Inexperience**

Team members have limited experience working in a system engineering project. Having limited previous experience in the systems engineering area may cause the AHNS personnel to spend more time than scheduled to complete tasks.

Effectiveness of Existing Controls: Fair

Likelihood: Moderate

Consequence: Moderate

Risk rating: High

**Risk Treatment**

1. Regular meetings with Dr Luis Mejias and advice from the senior personnel allow for clarification of queries and issues.
2. AHNS team members are allocated technical roles early in the project to provide maximum amount of time for familiarisation.

**Risk Treatment Type**

Administration

**Residual Risk Assessment**

Effectiveness of proposed Controls: Good

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature:

**Issue: 1st Revision**

**Date: .**

**HAZ – 21 – Budgetary Risk – Exhaustion of Funds**

**Cost of Parts**

Project components have associated monetary costs and will be allocated from the project budget. The cost of each purchased item will lower the overall project budget.

Effectiveness of Existing Controls: Good

Likelihood: Unlikely

Consequence: Major

Risk rating: High

**Risk Treatment**

1. To mitigate the risk of over expenditure, all purchases must be approved by the student project manager and must comply with the budget.

**Risk Treatment Type**

Administration

**Residual Risk Assessment**

Effectiveness of proposed Controls: Good

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature:

**Issue: 1st Revision**

**Date: .**

**HAZ – 22 – Budgetary Risk – Exhaustion of Funds**

**Damage to Helicopter and Onboard Equipment**

The helicopter hardware is what the project is based on. There is a risk of damage or complete loss of hardware in the event of UAV loss of control. Unforeseen replacement of helicopter hardware or components may cause an over expenditure of the project budget. This may lead to project failure due to insufficient funds.

Effectiveness of Existing Controls: Fair

Likelihood: Unlikely

Consequence: Major

Risk rating: High

**Risk Treatment**

1. An inclusion of replacement helicopter and parts must be included in the preliminary budget allocation.
2. Design of board equipment such that it is more resistant to damage.

**Risk Treatment Type**

Engineering

Administration

**Residual Risk Assessment**

Effectiveness of proposed Controls: Good

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature:

**Issue: 1st Revision**

**Date: .**

**HAZ – 23 – Budgetary Risk – Exhaustion of Funds**

**Technical Risks**

Possibilities that the AHNS project may be subject to one or many technical risks may cause budgetary problems. Unforeseen technical risks that have not been accounted for may cause an over expenditure of the project budget. This may lead to a project failure due to insufficient funds.

Effectiveness of Existing Controls: Satisfactory

Likelihood: Unlikely

Consequence: Major

Risk rating: High

**Risk Treatment**

1. Significant and very significant technical risks should be included as a possibility of project expenditure in the preliminary budget allocation.

**Risk Treatment Type**

Engineering

Isolation

Administration

**Residual Risk Assessment**

Effectiveness of proposed Controls: Good

Residual Risk Rating: Low

**Risk Assessment**

Assessed by: Date:

Position: Signature: