



# **AEROTHON 2021 - VIRTUAL AERO DESIGN CONTEST**

## **Rule Book**

Revision 3  
Mar 29, 2021

# REVISION HISTORY

<b>Revision</b>	<b>Date</b>	<b>Description</b>
1	Mar 10, 2021	Initial Version
2	Mar 17, 2021	Updates in Sections 1, 2 &3
3	Mar 29, 2021	Updates in Sections 2 &3

## FOREWORD

Welcome to SAEINDIA AEROTHON - Virtual Aero Design Contest 2021. The system requirements and performance scoring criteria were arrived at to align with real-world Air Vehicle (AV) requirements and provide a most realistic competition. Let's look at these metrics a little closer.

The contest is planned in two rounds a) Preliminary Round & b) Final Round. In the Preliminary Round, the teams must submit a design report of their AV, adhering to the contest design rules and guidelines. The top 5 teams in Preliminary Round will compete in the Final Round of the competition in a 24-hour Hackathon-type contest. Several design challenges/problems will be given to the qualified teams and the teams are required to find a solution to the given problem and make a presentation to the jury. Successful top teams will be shortlisted based on achieving the highest score on the defined performance metrics.

Universities/Institutes can nominate any number of teams as long as they meet the team formation requirements listed in this document.

Lastly, contesting teams are requested to pay special attention to the blue, bold and italicised fonts throughout this document. These are important updates and clarifications on a variety of aspects pertaining to the design. Please read these rules carefully. Please watch the SAEINDIA website for official announcements and updates concerning the competitions and rule interpretations.

Let the games begin. Best of luck to you all!!

**SAEINDIA Aerospace Forum**  
**SAEINDIA**

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# **1. COMPETITION REQUIREMENTS**

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## **1.1. INTRODUCTION**

### **Official Announcements and Competition Information**

The SAEINDIA AEROTHON - Virtual Aero Design Contest is intended to provide undergraduate and graduate engineering students with a real-life engineering exercise. The competition has been designed to provide exposure to students, to the real-life work environment of engineers. First and foremost, in this design competition, students will find themselves performing trade studies and making compromises to arrive at a design solution that will optimally meet the mission requirements while still conforming to the configuration limitations.

The importance of interpersonal communication skills is often overlooked by engineers, yet both written and oral communication skills are vital in the engineering workplace. To help teams develop these skills, significant weightage of the team's total score is provided to the Design Report and the oral presentation.

## **1.2. SAEINDIA AEROTHON RULES AND ORGANIZER AUTHORITY**

### **General Authority**

SAEINDIA AEROTHON - Virtual Aero Design Contest organizing committee reserve the right to revise the schedule of any competition and/or interpret or modify the competition rules at any time and in any manner that is, in their sole judgment, required for the efficient operation of the event or the SAEINDIA AEROTHON - Virtual Aero Design Contest series as a whole.

### **Penalties**

Organizers have the right to modify the points and/or penalties listed in the various event descriptions; to better reflect the design of their events, or any special conditions unique to the competition.

### **Rules Authority**

The SAEINDIA AEROTHON - Virtual Aero Design Contest Rules are the responsibility of the SAEINDIA Aerospace Forum Committee and are issued under the authority of the SAEINDIA. Official announcements from the SAEINDIA AEROTHON - Virtual Aero Design Contest Committee shall be considered part of and have the same validity as these rules.

Ambiguities or questions concerning the meaning or intent of these rules will be resolved by the officials, SAEINDIA AEROTHON - Virtual Aero Design Contest Rules Committee or SAEINDIA Staff.

### **Rules Validity**

The SAEINDIA AEROTHON - Virtual Aero Design Contest Rules posted on the SAEINDIA Website and dated for the calendar year of the competition are the rules in effect for the competition. Rule sets dated for other years are invalid.

### **Rules Compliance**

By entering the SAEINDIA AEROTHON - Virtual Aero Design Contest, the team members, faculty advisors and other personnel of the entering university agree to comply with, and be bound by, the rules and all rules interpretations or procedures issued or announced by SAEINDIA AEROTHON - Virtual Aero Design Contest Committee. All team members, faculty advisors and other university representatives are required to cooperate with, and follow all instructions from competition organizers, officials and judges.

### **Understanding the Rules**

Teams are responsible for reading and understanding the rules in its entirety effect for the competition in which they are participating. The section and paragraph headings in these rules are provided to facilitate reading: they do not affect the paragraph contents.

### **Participating in the Competition**

Teams, team members as individuals, faculty advisors and other representatives of a registered university who are listed as team members while registering the team are considered to be "Participating in the competition" from the time they register for the event until the conclusion of the competition or earlier by withdrawing.

### **Violations of Intent**

The violations of the intent of a rule will be considered a violation of the rule itself. Questions about the intent or meaning of a rule may be addressed to the SAEINDIA AEROTHON - Virtual Aero Design Contest Organizers or SAEINDIA Staff.

## **1.3. TEAM MEMBER ELIGIBILITY**

Teams are required to read the updates posted on the SAEINDIA website. Teams must also be familiar with all official announcements concerning the competitions and rule interpretations released by the SAEINDIA AEROTHON - Virtual Aero Design Contest Rules Committee.

## **1.4. SOCIETY MEMBERSHIP**

Individual team members must be members of SAEINDIA.

***A university or institute can nominate as many teams as they wish by paying the requisite fee for each team. However, each team must work independently.***

The registration fees indicated in the Section 1.5 must be paid within 15 days of registration.

Please note SAEINDIA AEROTHON - Virtual Aero Design Contest competition has a limit of 40 teams. Registrations will not be accepted once the limit is reached. It is recommended to register early and reserve a slot in the competition.

## 1.5. REGISTRATION REQUIREMENTS & INFORMATION

A Team can comprise a maximum of 7 students and 2 faculty advisors. All the students must be a member of SAEINDIA. Faculty advisors are advised to become members of SAEINDIA, though it is not mandatory.

The **Registration fee** for AEROTHON is **Rs.5000/- per team**. To register for AEROTHON visit: <https://saeindia.glueup.com/event/aerathon-virtual-aero-design-contest-33371/>

If you are not an a SAEINDIA member, go to [www.saeindia.com](http://www.saeindia.com) and select the “Membership” link. Students will need to select the “Student Membership” link and provide the details as indicated. Please note all student participants must be SAEINDIA members to participate in the events. Alternate link to sign up for SAEINDIA membership <https://www.saeindia.org/become-a-member>

Faculty members who wish to become SAEINDIA members should choose the “Professional Membership” link. Please note this is not mandatory for faculty advisors.

## 1.6. NEW POLICY DEADLINE (FAILURE TO MEET DEADLINES)

***Teams registering for SAEINDIA AEROTHON - Virtual Aero Design Contest are required to submit a design report on the design of the air vehicle.***

***Failure to submit the required Design Report by the deadline will constitute an automatic withdrawal of your team. Your team will be notified after a day of no submission that we have not received your documents and after the 2 days your team’s registration will be cancelled and no refund will be given.***

## 1.7. DESIGN

The aircraft must be designed by the SAE International student members without direct involvement from professional engineers, faculty members, or related professionals. The students may use any literature or knowledge related to AV or aircraft design and construction and information from professionals or from professors, as long as the information is given as discussion of alternatives with their pros and cons and is acknowledged in the references in the design report. Professionals may not make design decisions, nor contribute to the drawings, the report, or the construction of the aircraft. The Faculty Advisor must sign the Statement of Compliance given in the Appendix A.

## 1.8. ORIGINAL DESIGN

Any aircraft presented for competition must be an original design whose configuration is conceived by the student team members. Photographic scaling of an existing model aircraft design is not allowed.

## 1.9. OFFICIAL LANGUAGES

The official language of the SAEINDIA AEROTHON - Virtual Aero Design Contest is English. Document submissions, presentations and discussions in English are acceptable during all the rounds of the competition.

## 1.10. UNIQUE DESIGNS

Universities may enter more than one team in each SAEINDIA AEROTHON - Virtual Aero Design Contest, but each entry must be a unique design, significantly different from each other. If the aircraft are not significantly different in the opinion of the Rules Committee and Organizer, then the university will be considered to have only a single entry and only one of the teams and its aircraft will be allowed to participate in the competition. For example, two aircraft with identical wings and fuselages but different empennage would likely not be considered significantly different.

## 1.11. FACULTY ADVISOR

Each team is expected to have a Faculty Advisor from the registered university or institute. The Faculty Advisor will be considered by competition officials to be the official university representative for that team. Faculty Advisors may advise their teams on general engineering and engineering project management theory but should not design any part of the vehicle nor directly participate in the development of any documentation or presentation. They may review the draft design reports and provide suggestions for the improvement of the report, prior to submission by the students.

## 1.12. IMPORTANT DATES

*Table 1.1 Competition Timeline*

Timeline	Schedule
28 <sup>th</sup> March 2021	Curtain Raiser
15 <sup>th</sup> April, 2021	Registration Closure for the AEROTHON contest
15 <sup>th</sup> May, 2021	Closure of submission of Design Report to AEROTHON as part of the Preliminary Round
31 <sup>st</sup> May, 2021	Announcement of teams selected for the final round
12 <sup>th</sup> & 13 <sup>th</sup> June 2021	Final round

### Preliminary Round

- This round invites innovative designs from the participant teams by 15<sup>th</sup> May, 2021
- The innovative designs will be evaluated, and the top five teams will be selected for the final round

### Final Round

- Top five teams will go through the design contest for 24 hrs duration



- Top 3 teams will be selected as winners of the contest

## 2. DESIGN REQUIREMENTS

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SAEINDIA Aerospace Forum is conducting SAEINDIA AEROTHON – Virtual Aero Design Contest to ignite the passion for Aerospace. The objective of AEROTHON is to inculcate innovative thinking, design skills and capabilities in young minds and foster them towards *Atmanirbhar Bharat* in critical unmanned aerospace technologies.

### 2.1. PRELIMINARY ROUND

The team shall design an air aerial vehicle which that can deliver essential items like medicines to remote areas and help in safety and surveillance operations with the following specifications:

*Table 2.1 Air Vehicle Design Requirements*

S.No.	Requirements
1.	Minimum Endurance – 3 Hrs
2.	Minimum Payload – 6 Kg
3.	Max Speed – 150 km/hr
4.	Above Sea Level (ASL) – 6000m
5.	Operational Temperature – (-15°C to 60°C)

Students are expected to bring innovation in adopting new technologies (advanced materials), propulsion, power system (battery, fuel cell, solar) and other systems in the overall design. Provide design and analysis details of various systems and sub-systems, selection of Commercially Off The Shelf (COTS) items like batteries, etc. Students should consider safety of the platform and the environment in the design and highlight the risks and how they have been mitigated in the design. Students may consider failure of the airframe and problems during take-off and landing. They can consider how it will affect the humans and properties.

### 2.2. FINAL ROUND

Design Requirements or Design Challenges for the Final Round will be given by the committee/jury on the day of the contest to the qualified teams.

### 3. DESIGN REPORT

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Design Report is the primary means by which a team is to convey to the judges how they arrived at their design decisions, such that their unmanned aircraft system is most suited to perform the intended mission. The Design Report should explain the team's thought processes and engineering philosophy that drove them to their conclusions. Further, it should detail the methods, procedures, and where applicable, the calculations used to arrive at the presented solution.

Students are required to submit a design report with the following content for the preliminary round:

- a) Mission profiles
- b) Conceptual Design
  - I. High-level physical view: Physical elements and their arrangements
- c) Detailed Design
  - I. Wing Selection (Wing location, aspect ratio, taper ratio, wing twist, aerofoil selection, wing planform). This is an example provided for a fixed-wing aircraft design. However, for Vertical Take-off and Landing (VTOL) Fixed-Wings and VTOL designs, the teams may provide the design steps and calculations as deemed appropriate.
  - II. Horizontal and vertical tail sizing. Note: This is as required in the design.
  - III. Fuselage layout
  - IV. Propulsion selection. Electrical propulsion will require battery design details.
  - V. Material selection
  - VI. Detailed weight breakdown (CG & Static Margin)
  - VII. Landing gear
  - VIII. Aircraft performance
  - IX. Flight envelope (V-n Diagram)
  - X. Aerodynamics (Parasite drag build- up, Drag Polar & L/D max)
  - XI. Stability and control. Architecture involving sensor, computer and actuator need to be provided if required by the design.

- XII. Structural analysis (Wing load distribution, spar and rib sizing, etc.)
- d) CAD drawings and models (2D drawings of the front view, top view, side view; 3D models). Model-Based Definitions (MBD) can be submitted in lieu of 2D drawings.
  - e) Analysis Results (as required) – Hand calculations, Stress analysis and Computational Fluid Dynamics
  - f) Assumptions for component sizing
  - g) Selection of COTS items
  - h) Conceptual layout of how the air vehicle will be used for drug delivery, safety, and surveillance operations
  - i) Architecture of the telemetry and ground control and override need to be provided where required by the design.
  - j) Trade studies conducted to evaluate various alternatives
  - k) Summary of innovations in the overall design

### **3.1. ORIGINAL WORK**

The Technical Design Report shall be the team's original work for the current competition year. Resubmissions of previous and current year's design reports will not be accepted. Recitation of previous year's work is acceptable if and only if appropriately cited and credited to the original author(s). Plagiarism is a forbidden industry and academic practice. All references, quoted text, and reused images from any source shall have appropriate citation within the text and within the Technical Design Report's Table of References, providing credit to the original author and editor.

Reports may be checked against previous and current years' submissions to determine if re-use, copying, or other elements of plagiarism are indicated.

For the purposes of the SAEINDIA AEROTHON – Virtual Aero Design Contest, plagiarism is defined as any of the following:

- a) Use of information from textbooks, reports, or other published material without proper citation
- b) Use of sections or work from previous SAE Aero Design competitions without proper citation

If plagiarism is detected in the design report, the team will be disqualified, or points will be deducted as deemed by the rules committee/jury depending on the amount of plagiarised content present in the design report.

The SAEINDIA AEROTHON – Virtual Aero Design Contest Rules Committee & SAEINDIA has the sole discretion to determine whether plagiarism is indicated, and the above rules are enacted. The above rules may be implemented at any time before, during, or for up to six (6) months after the competition event.

## **3.2. DESIGN REPORT REQUIREMENTS**

### **3.2.1. Page Limit**

The design report must not exceed thirty (30) single-spaced, typewritten pages, including appendices, Cover Page, Table of Contents, and Prediction Graph. If the design report exceeds thirty (30) pages, the judges will only read and judge the first thirty pages.

Tables, charts, graphs, 2D drawings and Statement of Compliance will not be counted toward the 30-page limit.

### **3.2.2. Electronic Report Format**

All reports must be submitted in (.PDF) format only.

The document should be submitted electronically, and no handwritten documents will be accepted.

### **3.2.3. Font**

The minimum size type is 12 point proportional or a 10 character per inch non-proportional font.

### **3.2.4. Margin**

The report margins shall be: 1" Left, 0.5" right, 0.5" top, and 0.5" bottom. Each page, except the cover page, Certificate of Compliance, 2D Drawing and technical data sheet shall include a page number.

### **3.2.5. Page size**

All report pages shall be A4 portrait format.

### **3.2.6. Cover page**

All Design Reports must feature a cover page that states the team's name, college or university, and team number. The cover page will count against the 30-page limit.

### **3.2.7. Submission of Reports**

Teams are required to upload a PDF file by the deadline date at the web link.

## **3.3. ELECTRONIC PLAN REQUIREMENTS**

### **3.3.1. Format Size**

Plan sheet must be in AA3 page (PDF) format (11 x 17 inches). Plans must only consist of one (1) page and must have the US-standard third-order projection.

### **3.3.2. Required Views**

The plans shall consist of a standard aeronautical three-view, using a US-standard third-order projection; i.e., right side view in the lower left with the nose pointing right, top view above the right side view also with the nose pointing right, and front view in the lower right.

### **3.3.3. Dimensions**

At a minimum, air vehicle must have the length, width, height, and CG location clearly marked and dimensioned on the submitted engineering drawings. All dimensions must be in Metric units to an appropriate level of precision. (Hint: four decimal places are too many!)

### **3.3.4. Summary Data**

The plans must also contain a table with a summary of pertinent air vehicle data such as wingspan, empty weight, motor/engine make and model.

### **3.3.5. Weight and Balance Data**

The plans must also contain a weight and balance table with a summary of pertinent aircraft equipment (motor/engine, battery, payload, ballast, etc.), location from datum in inches, moment arms and resultant moment of CG.

- All aircraft must have a designated aircraft datum indicated on the 2D drawings.
- All aircraft drawings must indicate the following static CG margins: forward CG limit, aft CG limit and empty weight CG. Hint: Weight and Balance worksheet should correspond with static margins on 2D drawings.

### **3.3.6. Other Required Markings**

The plans must be marked with the team name and university or institute name.

## **3.4. SUBMISSION DEADLINES**

The Design Report and 2D drawing plans must be electronically submitted to SAEINDIA no later than the date indicated on the Action. Neither the Organizer nor the SAEINDIA is responsible for any lost or misdirected reports, plans, or Server routing delays. SAEINDIA will not receive any paper copies of the reports through regular mail or email.

## 4. COMPETITION SCORING

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### 4.1. PRELIMINARY ROUND

The design report submitted for the preliminary round will be used for the evaluation. The following are the parameters for the evaluation

*Table 4.1 Evaluation Criteria for Preliminary Round*

S.No.	Parameter	Score
1.	Technical Content	60
2.	Practical Application and Feasibility	10
3.	Innovation	20
4.	Originality	10

### 4.2. FINAL ROUND

The results produced during the design hackathon will be assessed in the final round for the evaluation as per the guidelines given below:

*Table 4.2 Evaluation Criteria for Final Round*

S.No.	Parameter	Score
1.	Technical Content	40
2.	Practical Application and Feasibility	10
3.	Innovation	20
4.	Originality	10
5.	Presentation	20

## 5. DESIGN REPORT GUIDELINES

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### 5.1. INTRODUCTION

Technical report writing is a skill that is different from informal writing – letters, notes, email – and, like all skills, needs practice to be mastered. The SAEINDIA AEROTHON - Virtual Aero Design Contest 2021 provides an excellent opportunity for students to exercise this skill. This document provides guidelines to help design teams write clear, succinct, and data-rich reports. The guidelines are grouped in three areas: organization, writing process, and writing clearly and succinctly.

### 5.2. ORGANIZATION

Reports are written for a person or group to read, and these readers have a purpose for reading the report. In the SAE competition, the readers are judges, and their purpose in reading is to grade the paper. Therefore, the design team authors should write the design report using techniques that make it easy for the judges to grade. Organizing the report for the reader's purpose is the first technique in effective technical writing.

**Outline** - The judge's grade criteria predominantly depends on the technical aspects. So the teams are expected to,

- Explain the team's thought processes and engineering philosophy that drove them to their conclusions
- Detail the methods, procedures, and where applicable, the calculations used to arrive at the presented solution
- Cover these topics
  - ❖ Vehicle configuration selection
  - ❖ Wing plan form design including airfoil selection
  - ❖ Drag analysis including three-dimensional drag effects
  - ❖ Aircraft stability and control
  - ❖ Power plant performance including both static and dynamic thrust, performance prediction
  - ❖ Other as appropriate

It also covers the administrative aspects of the report – page limits, formats, and specific graphs and drawings.

Although it may be harder to write the report to this outline, it will be easier for the judges to grade. This outline also forces the team to address topics the judges must grade and develop necessary data.

### 5.3. WRITING PROCESS

Writing a multi-page design report can be made less daunting by using a multi-step process. The first step is described above, generating an outline that addresses the reader's purpose. The next steps, described below, help in generating a data-rich, well-edited design report.

**Allocate Pages** – Allocate the 30 pages to the sections of the outline. The allocations should reflect the emphasis areas of the team's design. Do this before writing begins and adjust after reviewing the first draft. For each page of the design report, define the topic to be discussed and the message to be delivered. Make writing assignments for each page. Giving authors page-by-page assignments makes it easier to attack the writing – they are writing only one page at a time.

**Create the Figures** – Most judges will be engineers, and engineers are graphically inclined - they can understand a concept more easily when looking at a picture. Therefore, build each page around at least one figure. Create the figures first and review them before starting to write. Each figure needs a message which should be summarized in the figure title. Make the figures data-rich, but legible (9-point font is a minimum size - another advantage of using figures is that the rules do not constrain type font or spacing on figures). Equations can be incorporated in figures to save space.

**Draft the Text** - Use text to highlight, explain, or further develop the major points of the figure. Writing guidelines for clarity and succinctness are presented in a subsequent section.

**Edit the Text and Figures** – Take the time to edit the document at least twice. A good approach is to perform one edit cycle based on a group review of the draft document (called a Red Team). Have the Red Team members read the document as judges, supplying them with a scoring sheet and a copy of the rules

**Create the Final Document** – Although several persons may contribute to the writing process, one team member should make the final version. This person works to achieve a consistent style to the text and to make the messages consistent.

**Schedule the Effort** – Although this is the first step, I describe it last so that the reader can see what the team needs to schedule! A good report takes more than a week to create. One month is a guideline for the duration of the writing effort. Create a schedule of the above tasks and status it regularly. An efficient method is to establish the outline, page allocations, and figures early in the project, so the team can generate the necessary data as the design progresses. This reduces both the last-minute cram and the amount of unused documentation.



## 5.4. SUGGESTED DESIGN REPORT OUTLINE

Cover Page

Statement of Compliance

Table of Contents

List of Figures and Tables

List of Symbols and Acronyms

1.0) Introduction

- Objective
- Requirement Statement  
*(good place to insert a Figure that lists the design requirements)*

2.0) Design Process

2.1) Research

- Discussion of Concepts
- Discussion of previous design/concepts/publications
- Test & Experiment  
*(Don't be reticent to describe knowledge gained from previous competition entries)*

2.2) Design Analysis and Review Process

Discussion of results

2.3) Design Selection Process

Why certain design was selected over others *(vehicle configuration selection)*

*(In 2.2 and 2.3, explain the team's thought processes and engineering philosophy that drove them to their conclusions)*

3.0) Calculations *(equations, Calculation, Charts, and/or Tables)*

3.1) Aircraft Sizing

*Wing plan form design including airfoil selection*

3.2) Performance

- *Drag analysis including three-dimensional drag effects*
- *Power plant performance including both static and dynamic thrust*
- *Performance prediction*

3.3) Stability and Control

*Aircraft stability and control, Models for control.*

3.4) Weight Build-up and Analysis

3.5) Structural Analysis

*(In 3.1 through 3.5, detail the methods, procedures, and where applicable, the calculations used to arrive at the presented solution and also cover the requirement of Section 3)*

3.6) Power computations

4.0) Innovations (write only to innovations incorporated in the design – don't create words to fill a section. Leave blank if there is nothing to say. However, the team should be challenged to address all topics in the design)

References

Appendix A – Plans

## **6. REFERENCE BOOKS**

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- ❖ Aircraft design: A conceptual approach - Daniel P. Raymer
- ❖ Introduction to Flight - John D. Anderson
- ❖ Fundamentals of Aerodynamics - John D. Anderson
- ❖ Airplane Performance and Design - John D. Anderson
- ❖ Flight stability and automatic control, Robert C. Nelson
- ❖ Airframe stress analysis and sizing – Michael Chun-Yung Niu
- ❖ Aircraft Structures, T.H.G. MEGSON (4th Edition)

## APPENDIX A

### STATEMENT OF COMPLIANCE

#### Certification of Qualification

Team Name: \_\_\_\_\_ Team Number: \_\_\_\_\_

University/Institute: \_\_\_\_\_

Faculty Advisor: \_\_\_\_\_

Faculty Advisor's Email: \_\_\_\_\_

#### Statement of Compliance

As Faculty Advisor, I certify that the registered team members are enrolled in collegiate courses. This team has designed, constructed and/or modified the radio-controlled aircraft they will use for the SAE IBS Aero Design 2016-2017 competition, without direct assistance from professional engineers, R/C model experts or pilots, or related professionals.

\_\_\_\_\_  
Signature of Faculty Advisor

\_\_\_\_\_  
Date

#### Team Captain Information:

Team Captain's Name: \_\_\_\_\_

Team Captain's E-mail: \_\_\_\_\_

Team Captain's Phone: \_\_\_\_\_

**Note:**

A copy of this statement needs to be included in your Design Report as page 2