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Mission Requirement & Preliminary Design Review Documentation Guidelines

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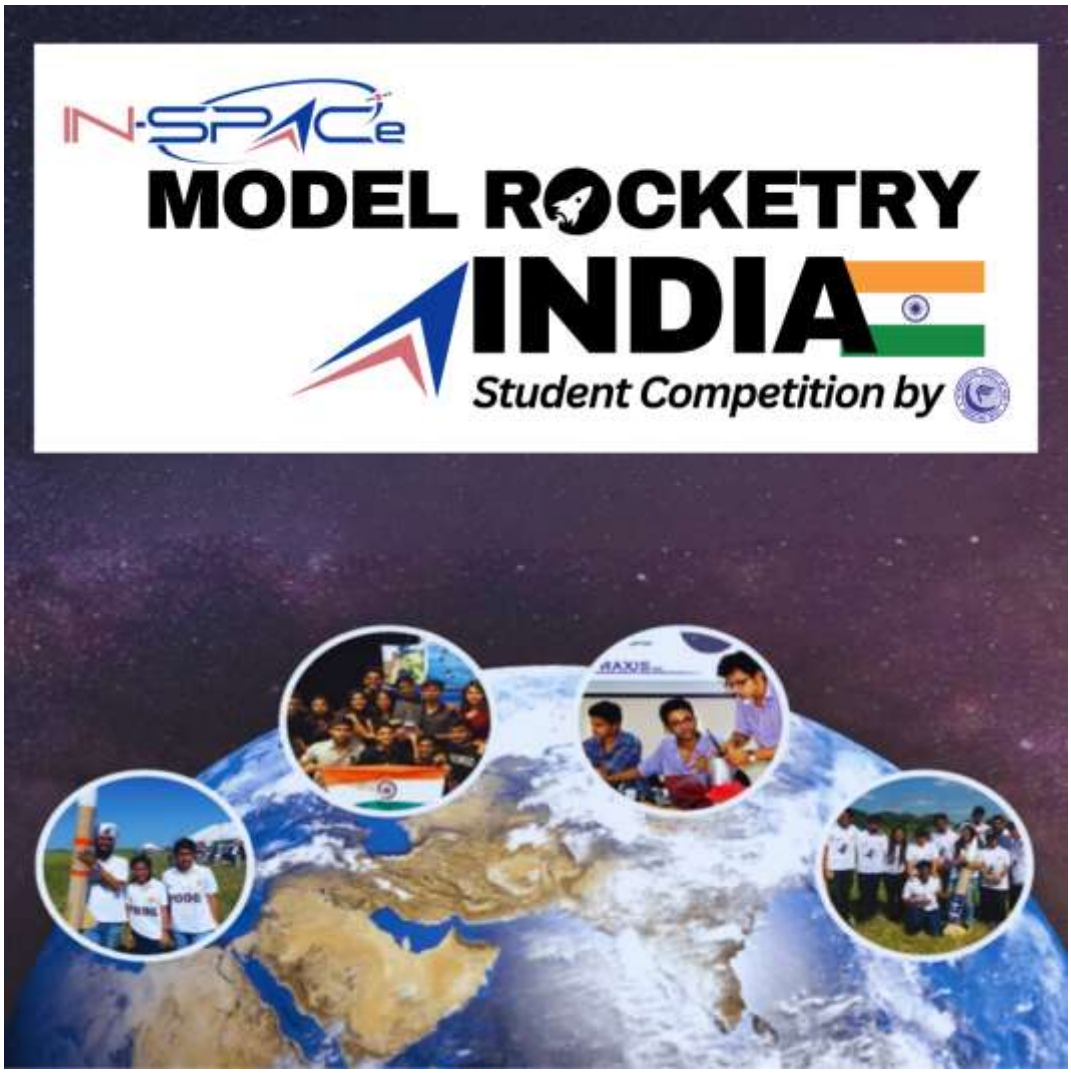

ASTRONAUTICAL SOCIETY OF INDIA
U. R. Rao Satellite Centre
Bengaluru 560017

IN- SPACe Model Rocketry India Student Competition 2024 - 2025

by

ASTRONAUTICAL SOCIETY OF INDIA

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August 2024

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MISSION REQUIREMENTS &

PRELIMINARY DESIGN REVIEW DOCUMENTATION GUIDELINES

	Name and Designation	Date	Signature
Prepared by	**Team Model Rocketry**	**August 2024**	
Reviewed by	**Organizing Committee**	**August 2024**	
Approved by	**Executive Secretary, ASI**	**August 2024**	

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Executive Summary

IN-SPACe Model Rocketry India Student Competition 2024 – 2025 by ASI is a Model Rocketry Competition conducted for Engineering / Science stream students in India. The competition is conducted by Astronautical Society of India (ASI) and in collaboration with ISRO and IN-SPACe. The competition aims to inculcate awareness on rocketry among the student community in India, and help develop a technologically skilled workforce in STEM generally, and space sector specifically. The document details the guidelines for participation in the competition in order to enable the students to get a comprehensive understanding, regarding the design, material procurement, qualification tests and other related aspects.

The document contains details on the Competition Objectives, Challenge Statement, Competition Phases and the System requirements of the launchers that the teams will have to design. The System requirements further is sub-divided in to Basic rocket requirements, Payload, Structure, Avionics, Ground Station, Telemetry etc, and the document provides guidelines on these areas. The student teams are advised to keep the requirements provided as the baseline, and adhere to the same. Any deviations from these, shall be informed and approved by the Jury Panel. Further, basic details of the proposed workshop are also provided.

The student teams may use this document as a guideline for preparing the PDR & CDR and to understand the overall flow of the competition. Further competition requirements, like the Evaluation Matrix, Workshop Modalities etc shall be intimated to the student teams in due course, through IN-SPACe Website (www.inspace.gov.in) / ASI website (www.asindia.org) and e-mails.

1 Introduction

IN-SPACe Model Rockery India Student Competition 2024 – 2025 is being organized by Astronautical Society of India in association with ISRO and IN-SPACe. This competition aims to provide Undergraduate Student teams of Engineering / Science Streams in India, a realistic experience in designing and launching an amateur rocket that meets a specified set of mission and performance requirements. The competition involves the design, development & launch of a Model Rocket carrying a CAN-Size Satellite of 1Kg mass to an altitude of 1km above the launch site, along with safe ejection of the CANSAT, operation of payload and safe recovery of the rocket and CANSAT. The participants are expected to learn basics of Rocketry – systems design, propulsion, structural systems etc, along with soft skills like Team building, co-operation, project Management, and Interpersonal communication, among others. Over a period of several months, the participants shall experience the engineering processes for realizing a launch vehicle, and compete with peer groups from all across the country, with an opportunity to participate in a national level final expected to happen between March – June 2025, at a place to be finalized by Organizers.

The purpose of the program is to inspire and excite students about learning and to pursue careers in Science, Technology, Engineering and Mathematics. The competition is defined to be well within the capabilities of the students, and the respective colleges are encouraged to conceive academic grace marks / any other incentivizing mechanism for students who participate in the competition. In addition, it is also envisaged that the participating universities moderate to select a suitable set of Mentors to help students in the design phase. The participating teams will be trained on Amateur Rocketry through a one-week, paid, IN-SPACe skill development program. The skill development program shall have hands-on workshop for the participating teams in order to train the student teams in the practical aspects of rocket modelling.

This document provides the guidelines for the IN-SPACe Model Rocketry India Student competition 2024 – 25 by ASI. The Competition statement along with Optional Indicative requirements for the same are provided. Teams are free to select any novel techniques to

demonstrate the same. The teams will be provided 3 variants of Solid Motors depending on the rocket body material selected by the teams. The basic system requirements like Motor dimensions and Motor types along with that of Payload, structure, power system, descent and recovery system, communication system, Flight Software etc. are provided for information of the participating teams.

The guidelines for team composition & management, Design and development studies of various systems and subsystems, Hands-on workshop for building and launching model rockets etc. are enumerated. The code of ethics and standards that need to be maintained by the teams is also provided in the document.

The teams shall use the unique Team Identification Number allotted for all future correspondence with the Organizers. All such correspondences shall be through the faculty advisors identified for this competition.

2 Competition Objectives

1) To inculcate consciousness about rocketry across the country.
2) To inspire and excite students about learning and careers in science, technology, engineering and mathematics
3) To develop a technologically skilled future workforce for Space Sector in India

3 Competition Phases

The competition shall be conducted in the seven phases which are as follows:

Phase	Activity	Output
Phase – 1	**Registration Phase** In this phase, the teams are required to register at www.inspace.gov.in as per the competition guidelines provided in Annexure – I of this document. The participants can be	Team Registration

	1) Undergraduate students from Engineering / Science background enrolled in Indian colleges/universities	
Phase – 2	**<u>Preliminary Design Phase</u>** Submission of Preliminary Design Review (PDR) document followed by a presentation to the Jury. This round is expected to a graded round, depending on the submitted PDR, and the reviews. Based on the performance during PDR, the Jury will recommend teams for the next phase of the competition.	**First round of Progressive Grading** Teams shall be graded based on their fundamental understanding of rocketry, systems, sub-systems and propulsion techniques, including Motor design for the given altitude and payload mass.
Phase – 3	**<u>Rocket Modelling Workshop</u>** The PDR qualified teams shall undergo a one-week IN-SPACe short-term skill development model rocketry course. This course will have hands-on practical sessions to design, develop and launch the scaled down version of amateur model rockets, depending on the prevailing conditions. The teams shall have to undergo and pass a mandatory quiz on Rocket Modelling.	**Second Round of Progressive Grading** Teams shall be graded based on their successful hands-on experience on building a rocket, along with aspects like Team building, Project Management, etc.

Phase – 4	**<u>Critical Design Review (CDR) Phase</u>** All the teams who successfully completed the workshop, shall submit a comprehensive Critical Design Review Document, that includes the design parameters of their rocket, along with the performance parameters. The evaluation committee will grade the teams based on various technical factors as defined, and select the teams for National Finals. The decision of Jury Panel shall be final and binding on all the participating teams. During this phase the teams shall finalize the design, initiate the components and material procurement and start the realization of the rocket	**Third round of Progressive Grading** Assessment of rocket designs & selection for the National Finals. The selection shall be based on the marks provided by the Jury during the PDR, Rocket Modelling Workshop and CDR phase. The scoring template shall be developed by the Jury
Phase – 5	**<u>Flight Readiness Review (GO – NOGO criteria)</u>** The selected teams shall undergo Flight Readiness Review by Jury. The decision of jury shall be final and binding to the teams cleared for the launch for the finals.	Flight readiness check & clearance for launch. **NB:** The punctuality of the teams is of utmost priority. The teams not reporting on time, shall be debarred from further participation in the competition.
Phase – 6	**<u>Launch</u>**	Launch & Mission Evaluation

	The teams cleared in the FRR phase, shall be allowed to launch their rockets during the finals	
Phase – 7	**Post flight Analysis (PFA)** The evaluation committee / Jury shall review the flight results and grade the teams to decide on the final winners, three to five Student teams.	Final Evaluation & announcement of winners

The detailed guidelines, as applicable regarding the technical aspects, programmatic or regulatory aspects with the necessary timelines, during any subsequent phases of the competition shall be notified in due course through IN-SPACe website www.inspace.gov.in / ASI Website www.asindia.org and through e-mail.

4 Competition Statement

4.1 Competition Statement for IN-SPACe Model Rocketry Competition

1. Build a rocket that can reach an altitude of (1000m +/- 100m) with the help of Solid Motor provided by the organizers. Three options of Solid Motor shall be provided to the participating teams to select from. The rocket shall be able to carry a payload of (1.0 Kg +/- 0.05 Kg) with it. The teams will be evaluated on the following parameters:
    a. Rocket frame design and innovation
    b. Launchpad design and innovation
    c. Flight stability & performance
    d. Avionics & continuous data collection
    e. Ignition / Recovery
2. Comprehend the theoretical basics involved in rocketry, and enumerate the concepts, design and development process to be followed in the realization of the vehicle in the PDR and CDR documents, as part of the competition phases.

3. Participate in the one-week short-term skill development model rocketry course to be conducted by IN-SPACe, and successfully demonstrate the launch of a scaled down Amateur Model rocket, as the outcome.

4.2 Indicative Optional Requirements

A few indicative optional requirements that the participating teams can consider are listed below. However, teams are encouraged to propose novel techniques that they can demonstrate within the specified mass, power and budget constraints.

i. Innovation in Materials used / Ignition concepts

ii. Innovative separation mechanisms / Jettisoning System

iii. Good theoretical understanding of the rocket systems and sub-systems to be demonstrated in the documents – PDR and CDR, and in the evaluation by the Jury.

iv. Innovative Process – Quality Control (Reliability Analyses Methodologies)

a. Adherence to Standards that are followed, like the MIL Standard / Indian Standards released by IN-SPACe / The European Cooperation for Space Standardization (ECSS), etc shall be considered for extra points.

v. Additional innovative sensors and communication systems

vi. Provision of video capture of the flight, and till touchdown of the launcher

vii. Innovative recovery techniques viz. HAM radio/Advanced beacons.

viii. Scientific experiment onboard the rocket

5 System requirements

5.1 Basic rocket requirements

i. The lift off rocket mass must be within +/-5% of the design value. The overall length of the rocket as measured from the lowest to the highest points of the airframe structure (including fins) in launch configuration, shall be less than **180cm**.

ii. Three types of motors are envisaged to be provided by organizers, considering Aluminum, Cardboard or PVC as materials for the Rocket Body. The body mass including Motor shall not be greater than 15Kg (Aluminum body), 10Kg (Cardboard body) and 11.5Kg (PVC body). The motor mass shall be around 3Kg. However, this requirement is subjected to change depending on the PDR reports provided by the teams. The Organizers may insist on standardizing the rocket body, depending on the number of applications for each rocket body type, Design calculations, etc. Any innovative materials proposed by the teams, shall be provided with a Motor, that most closely matches the specifications provided above. The tentative details of the same are covered in Chapter **12 SELECTION OF MOTOR PROVIDER**

iii. The provision for Bulkhead / Integration of Motor Compartment should be made available in the Rocket body.

iv. The teams shall design and bring their own launch pads, and the launch angle shall be in the range of 80^0 - 85^0. This shall be verified by the Jury Panel before giving clearance for launch.

v. All parts of the rocket (other than disposable recovery wadding if any) must descend tethered together and must use parachute recovery.

vi. The rockets must have only one stage that shall be powered only by commercially-made model rocket motors, procured from Vendors identified by organizers.

vii. The rocket motor capacity designed by teams cannot exceed 2800 Newton-seconds of total impulse.

viii. Motors must be retained in the rocket during flight and at ejection by a positive mechanical means (clip, hook, screw-on cap, etc.) and not retained simply by friction fit in the motor mounting tube, but they must be removable post-flight.

ix. The payload Separation mechanism shall be developed by the teams for activation at the desired altitude.

x. Care must be taken to ensure that the explosives must be handled only in the manner prescribed in the instructions for the motor.

xi. Any sharp edges on the container body shall be avoided as it can cause problems during the CANSAT ejection from the rocket.

xii. The body of the rocket structure shall be painted with fluorescent colors i.e., pink, red or orange.

xiii. The Amateur Model Rocket shall consist of necessary sensors to provide the following mandatory Real-time datasets: Position data, altitude, pressure, temperature, orientation data, power data & system status.

xiv. The teams are encouraged to use the Global Navigation Satellite System (GNSS) receiver that includes Navigation by Indian Constellation (NavIC).

xv. The data shall be displayed in near real-time on the ground station User Interface/Software. Teams are free to use any design to build their own user interface.

xvi. The Flight software system shall have provision to record the data and save it on an onboard SD card, in case of telemetry connection loss during flight.

5.2 Payload Requirements

i. Rockets shall contain and completely enclose in straight line configuration, a CAN-Sized satellite of diameter 0.15m and length 0.40m, with a weight of 1Kg +/-0.05Kg.

ii. The CANSAT (Payload) must be separated and deployed at the defined altitude (1000m +/- 100m).

iii. The Rocket body and the CANSAT shall return safely to the ground by means of safe landing, using deployable parachutes.

iv. The CANSAT shall be procured by the teams. The CANSAT shall contain an altimeter and an accelerometer that will measure the altitude and acceleration levels reached by the vehicle. This data shall be correlated with the Vehicle data and Telemetry data that the participating teams shall have to obtain, and provide to Jury for evaluation.

v. Onboard Experiment Module (**Optional**)

- Teams are free to choose the nature of their experiment. It can be related to physics, chemistry, biology, environmental science, or any other field of study. The experiment should be designed to operate autonomously during the flight.
- Teams must include a detailed proposal outlining their experiment, including objectives, methodology, expected outcomes, and any relevant calculations or simulations along with the PDR submission, with basic guidelines to be considered, given below.
- The specifications and requirements of the CANSAT including the Power systems, Descent systems etc may be referred to in the Document Ref: ASI.MR.PDRDG.01; Issue No.1; Dtd 04/06/2024 IN-SPACe CANSAT India Student Competition 2024-25 (2nd Edition): Registration, Mission Requirement and Preliminary Design Review Documentation Guidelines.
- Technical Specifications:
  - ✓ The experiment must fit within the payload bay of the model rocket.
  - ✓ The total weight of the experiment, including any necessary support structures, must not exceed the specified payload capacity of the rocket.
  - ✓ The experiment should be designed to withstand the forces and conditions experienced during launch, flight, and recovery.
- Safety Requirements:
  - ✓ All materials and components used in the experiment must be non-hazardous and comply with some identified safety standards.
  - ✓ The experiment must not interfere with the rocket's flight stability or recovery system.

- ✓ Teams must provide a detailed safety assessment of their experiment, including potential risks and mitigation strategies.

5.3 Structure Requirements

i. The vehicle structure shall be built to survive 15g of launch acceleration & 30g of shock.

   a. All the structural margins of the Model Rocket shall be substantiated by theoretical calculations and Finite Element Analysis (as applicable) in the PDR / CDR documentation.

   b. Tri- axis accelerometers shall be mounted on the vehicle to derive the Inertial loads (g levels), that shall be plotted and submitted to the Jury.

   c. The design calculations shall also substantiate the structural loads experienced on the vehicle including the joints and fasteners, as the case may be.

ii. Team number, email address and phone number must be placed on the structure in English, Hindi and the regional language of the launch state to aid in recovery.

5.4 Avionics System Requirements

i. All electronics shall be enclosed and shielded from the environment by suitable packaging. No electronics can be exposed except for sensors. There must be a structural enclosure.

ii. Electronic circuit boards must be hard mounted using proper mounts such as standoffs and screws. High-performance adhesives can also be used.

iii. **Power Requirements**

- ✓ The launcher ignition shall be carried out remotely, and accordingly an external power switch with an Indicator light or sound shall be provided.

- ✓ Battery capacity to support up to 30 Minutes of wait-in on the launch pad with additional time for flight operations, shall be ensured.
- ✓ The battery source may be alkaline, Ni-Cad, Ni-MH or Lithium ion. Lithium polymer batteries are not allowed. Lithium cells must be manufactured with a metal package similar to 18650 cells.
- ✓ An easily accessible battery compartment must be included allowing batteries to be installed or removed in less than a minute and not require total disassembly of the Rocket / CANSAT mounted on the rocket.
- ✓ Spring contacts shall not be used for making electrical connections to batteries. Care must be taken as the shock forces can cause momentary disconnects of power.

iv. **On-board Launcher Communication Requirements**

- ✓ The Rocket communications radio shall be the XBEE / Zigbee radio series 1/2/pro / any other.
- ✓ The XBEE / any radios used shall have their NETID/PANID set to the team number.
- ✓ The XBEE radio / any radio being used can operate in any mode as long as it does not interfere with other XBEE / other communication systems.

v. **Flight Software of Launcher**

- ✓ The flight software shall maintain and telemeter an indicator of the flight software state. An example set of states is 0 (BOOT), 1 (TEST_MODE), 2 (LAUNCH_PAD), 3 (ASCENT), 4 (PAYLOAD_SEP), 5 (DESCENT), 6 (AEROBREAK_RELEASE), and 7 (IMPACT).
- ✓ In the event of a processor reset during the mission, the flight software shall be able to determine the correct state.
- ✓ The states shall be described in the review presentation by each team.

5.5 Ground Station

i. Each team shall develop and use their own ground station. All telemetry shall be displayed in near real-time during launch and descent. All telemetry shall be displayed in international system of units i.e., SI system. Teams shall plot data in real-time during flight.

ii. The ground station shall command the Model Rocket to start transmitting telemetry prior to launch. The rocket shall not transmit telemetry until commanded by the team.

iii. The teams shall ensure to have separate channels for rocket and CANSAT, with an interference test to be demonstrated to the Jury to avoid any overlapping between both.

iv. The teams can issue the telemetry command, only post the on-site inspection and clearance by the Jury members. A Pre-set checklist for clearance shall be made available for the teams, basis which the jury shall inspect and clear the vehicle for launch on the pad.

v. The ground control station antenna shall be elevated from ground level to ensure adequate coverage and range.

vi. Stability of the ground station must be ensured.

vii. The ground station shall be able to command the rocket on parameters like barometric altitude, accelerometer readings etc, including zero-setting at the launch pad.

viii. The ground station shall generate .csv files of all sensor data as specified in the Telemetry Requirements section.

ix. Telemetry shall include mission time with one second or better resolution.

x. In case of processor reset, the mission clock/time stamp & system state shall be maintained.

xi. Teams shall plot each telemetry data field in real-time during flight.

xii. The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.

xiii. The ground station must be portable so the team can be positioned at the ground station operation site along the flight line and if required the team can also move to a different location, in case of distant landing location, in order to locate the projectile.

5.6 Telemetry

i. Upon powering up, the Rocket shall collect the required telemetry at a 1 Hz sample rate or better. The telemetry data shall be transmitted with ASCII comma-separated fields followed by a carriage return in the format as given in the Annexure – 2

ii. The received telemetry for the entire mission shall be saved on the ground station computer as a comma-separated value (.csv) file that will be examined by the Jury post the flight. Teams will provide the file to the Jury immediately after the launch operations via USB drive. The .csv file shall include headers specifying each field of data.

iii. The telemetry parameters display format with resolution along with the file naming shall be as per Annexure - 2.

iv. Additional data fields may be appended after the required fields as determined necessary by the team's design

v. It is suggested that teams make use of onboard data storage as a Redundant Mechanism. Only the transmitted telemetry is graded, however, the backup data can be used when completing the Post Flight Review.

5.7 Descent & Recovery requirements

i. The Rocket shall contain a minimum of one descent control mechanism (parachutes) to be used during the descent phase. It is the responsibility of the teams to ensure that both the rocket and the CANSAT descent safely and securely. 1st mechanism shall be a parachute while any additional mechanism can be decided by the teams. Few examples for the second descent control mechanism are: main parachute/streamer/glider/rotor mechanism etc.

ii. If the Rocket uses multiple stages of descent control, the first stage (drogue chute) shall deploy right after the release of the Payload.

iii. The descent rate of the launcher body and payload bay shall be between 2 to 5 m/s (+/- 0.5 m/s). The descent rate should be measurable during the competition.

iv. The CANSAT Payload shall not use any hazardous chemical-based explosive or pyrotechnic devices. However, green propulsion is allowed if being used under the same weight constraint.

v. The descent control mechanism & all the attached components should survive 30g of shock at the time of launch and separation.

vi. All the electronic components shall be enclosed and shielded from the environment with the exception of sensors.

6 Design Review Documentation Guidelines

Preliminary Design Review (PDR) - is a detailed design review of the system to ensure that the system can proceed into the realization phase, and can meet the mass, dimensional, budget, schedule and other specified constraints for the IN-SPACe Model Rocketry India Competition 2024 – 2025.

The PDR document shall contain a very comprehensive documentation on the design aspects of the vehicle, and the teams shall be graded depending on the clarity that the PDR

document and the review presentation bring, with regards to the competition statement and the methodology to achieve the same.

Critical Design Review (CDR) is an overall review summary of the system. Once the PDR phase is completed, the teams can proceed to the manufacturing, Qualification and Acceptance testing phase, with the results of all of these along with the Operations Management plan to be entered in the CDR document.

In summary, PDR document shall contain the design aspects in its entirety along with an overall plan of action for the project, while CDR document should contain the entire project summary with quantifiable results of the testing.

Among others, the PDR document shall consist of:

i. Details about the Mission requirements and how are they addressed.

ii. Details about derived and allocated system-level requirements

iii. Details about the operational aspects of the Rocket.

iv. Detailed overview of the preliminary design that meets the mission's specified requirements.

v. Details about the identified components, subsystems, processes, simulation results or any other details to support the preliminary design.

vi. Calculations-both theoretical and Software Analyses (Finite Element, Computational Dynamics etc) to demonstrate sufficient design margins for the components including interfacing joints and fasteners.

vii. The Stage-by-stage process to be followed for realization of the system, Operations, Integration Procedure (overall), Quality Checks etc, along with the standards adopted for the same.

viii. Details of the identified testing criteria to support or finalize the preliminary design.

ix. Budget details. If the teams are aiming to secure sponsorship for the same it shall be specified in the document.

x. Development schedule of the Rocketry Project.

The PDR document along with the presentation should be submitted as per the guidelines mentioned in the subsequent sub-headings. The team leader shall be responsible to present the slides in the specified format. The Presentation time shall be limited to 30 minutes. Anything longer than that will lead to deduction of points. In case of acronym usage, it has to be mentioned at the beginning of both the doc and PPT file. Any reference used is to be mentioned in Annexure's reference section.

The following are the points to be taken care of while developing the PDR document:

6.1 Team Composition and management

This includes the details of the team members i.e., course, graduation detail, institute, area of specialization (if any), and role in the team, to be filled accordingly for students and start-ups.

The team leader shall be primarily responsible for the presentation, including maintaining the timing and curating the flow of the presentation. The teams are required to mention the expenses envisaged during the entire rocket development, including the Bill of Material (BOM) of their purchase, to the extent possible in PDR and in its entirety in the CDR, including the following costing line items.

- Cost of each component
- Estimate vs Actual costs with deviations, if any
- Any second-hand hardware
- Ground station
- Parachute
- Designing

- Prototyping
- Testing
- Fabrication
- Contingencies
- Any other relevant cost

Any source of sponsors shall also be mentioned.

NOTE: ASI does not provide any kind of funding support to the participating teams.

A project milestone chart showing breakup of various activities like task start and stop dates and durations shall be included in the document. The purpose of the project timeline chart is to keep things on track and monitor the progress. Periodic update meetings are assumed to be scheduled to evaluate the team's progress.

6.2 Mission Overview

Mission overview should provide the overall mission objective. This should include all the primary and the secondary/add-on objectives that the team is looking for. A comprehensive summary of the requirements that are used in the design assumptions shall be provided in the document.

The requirement of lab facilities if any, along with any external support taken from the facilities apart from the participating institute needs to be mentioned here.

The system overview should cover all the design traits taken care while at the development stage. Diagrams, demonstration tables and figures shall be included wherever necessary.

The System Overview presentation should include:

- Rocket Configuration
- Major components

- Engineering drawings
- Launch and descent strategy
- Post-launch recovery
- Data retrieving and Analysis

6.3 Subsystem Details

6.3.1 Payload Subsystem

The Payload shall be the CANSAT. As already covered in **Section 5.2 Payload Requirements,** all the details regarding the experiments planned to be conducted shall be included under this section. The details of the deceleration system planned for the CANSAT, along with steps taken to avoid interference or causing damage to the payload shall be explained in depth in this section. The CANSAT requirements shall be referred to in Document Ref: ASI.MR.PDRDG.01; Issue No.1; Dtd 04/06/2024 IN-SPACe CANSAT India Student Competition 2024-25 (2nd Edition): Registration, Mission Requirement and Preliminary Design Review Documentation Guidelines.

6.3.2 Housekeeping Subsystem

The housing subsystem contains all the necessary sensors, actuators, attitude controls, power system, communication systems etc. The reference for the sub-systems may be drawn from the **Section5 SYSTEM REQUIREMENTS**

The housing contains the following subsystems.

a) Mechanical Subsystem

b) Communication and Data Handling Subsystem

c) Electrical Power Subsystem

d) Sensor Systems

a) Mechanical Subsystem

The mechanical subsystem should include all major structural components, container mechanical configurations, body tubes, Nose cones, nozzles, Separation actuators, Tethering systems, deceleration system etc.

The key constraints in mechanical designs of rocket hardware and component selection should be mentioned in detail. Any major trade-off should be mentioned separately.

A detailed explanation of the hardware along with schematics wherever possible shall be provided including the following points:

- ✓ Design & Simulations
- ✓ Methodology
- ✓ Integration and Positioning of the Sub-systems in the container

The team should clearly mention the Mass properties of the container, sensors, parachute, and any other components used in the rocket.

b) Communication and Data Handling Subsystem

The Communication and Data Handling Subsystem should mention clearly the TxRx antenna design & details, link margin, Boot time, Processor type, data interfaces, memory slots, Real-time clock, antenna material, XBEE / any other radio selection, transmission control, backup in case of transmission loss, data format, etc in adherence to Section **5.5. Ground Station.**

c) Electrical Power Subsystem

The Electrical Power Subsystem should include schematic showing power connections that includes all power sources, resistor arrangements and all major components. The Payload should have an external switch.

Note: Use of Lithium Polymer batteries is prohibited.

All types of connections and mounting need to be shown clearly. Describe the power trade-off and selection. The kind of connection done (parallel or series) needs to be explained in details.

The Power budget should include:

- ✓ Energy Balance
- ✓ Power consumption of each component/subsystem
- ✓ The total power consumed

d) Sensor Systems

The Sensor Systems details should include a summary of all the sensors selected and the purpose for which these sensors are being used. Detailed information like interfaces, resolution, weight, cost, reason for selection of each of the following sensors shall also be included in the documentation.

- ✓ GNSS Sensor
- ✓ Altimetry
- ✓ Pressure
- ✓ Temperature
- ✓ Accelerometer sensor (Orientation/Acceleration data) – to take in to account the duration of flight, and sensitivity to be accordingly decided.
- ✓ Power Status
- ✓ Any other sensor

The team is required to clearly mention any trade-off while sensors selection power requirements and other supporting documents.

6.4 Flight Software Algorithm Description

This section should include the details of functional requirements and mathematical formulations used in development of the flight software. The algorithm should be described in the form of a flow chart. The software change log should be maintained using standard software packages. This should also describe basic software architecture, programming language used, development environment and brief summary of the software tasks.

The following details should be included in the document viz.

- ✓ Software sequencing timing diagram
- ✓ Sampling rate or processor cycle time used for execution of various tasks
- ✓ Telemetry and Telecommand details
- ✓ Data storage and Handling
- ✓ Software reset loop
- ✓ Simulation mode strategy
- ✓ Test methodology
- ✓ Proto version testing details

6.5 Ground station

The ground station includes a laptop, antenna, power supply etc. The ground station is supposed to remain ON at the time of launch for real time data collection and processing. However, the following points are needed to be considered and mentioned in the presentation:

- ✓ Ground station power supply and duration of operation
- ✓ Antenna pattern
- ✓ Antenna type
- ✓ Telemetry display
- ✓ Command software and interfaces
- ✓ Real-time data collection scheme
- ✓ Last data command at console display
- ✓ User interface for real-time data collection
- ✓ Describe in simulation mode how the ground system transmits the commands and uploads the data.
- ✓ Ground software design for the transmitter to submit telemetry packets
- ✓ Sensors & Payload telemetry
- ✓ Libraries used
- ✓ Communication test plans
- ✓ The file format should be .csv for the data saved

6.6 Rocket Integration and Testing

This section shall contain the Team's methodologies used in the Integration and Qualification / Acceptance tests of the Components / Sub-systems / Systems of the Rocket, along with the specific requirements that are served through these tests. The teams are required to indicate the tests that are to be carried out for the competition, along with Test plans to achieve the tests. An indicative list of tests are provided below for consideration of the teams,

Mechanical Systems

- ✓ Functional Development Tests – Component / Sub-system / System level
- ✓ Functional Qualification Tests – Sub-system / System Level
- ✓ Structural Qualification Tests – Sub-system / System Level
- ✓ Vibration Tests – Sub-system / System Level (SINE, Random)
- ✓ Thermal Tests
- ✓ Fit checks
- ✓ Parachute Deployment Tests
- ✓ Acceptance Tests – System Level

Electronic Systems

- ✓ Command and Data Handling
- ✓ Power Supply
- ✓ Ground Station
- ✓ Flight Software
- ✓ Environmental Tests
- ✓ Check out
- ✓ Integrated level functional tests
- ✓ Simulation test plans
- ✓ Polarity tests
- ✓ Integration tests
- ✓ Interference Tests etc

6.7 Operations Plan & Quality Control

This section shall detail the Manufacturing process to be adopted for the components and sub-systems, along with the Quality Control plans and the Acceptance Criteria for such components. The section shall also detail the Assembly and Integration Procedure to be adopted for the rocket system, in addition to the sequence of activities that are to be followed at the launch site. In this context, any identification setups like color coding etc that the teams have adopted shall be mentioned.

The section shall also contain such activities required for the launch pad for ensuring the required fit for the rocket with the same.

Operations plan shall also contain the sequence of activities to be followed for data acquisition, data dissemination and collection / management of data. Last but not the least, an exigency management procedure shall also be included in this section.

7 Hands-on Workshop

A One-Week IN-SPACe short-term skill development Workshop on Amateur Model Rocketry shall be planned in the lines of the short-term courses conducted by IN-SPACe. This workshop will give the students a first-hand experience in to the concepts of rocketry. The areas of rocketry that the students shall be exposed to include,

1) Design of Propulsion Systems
2) Structural Design
3) Flight Dynamics and Control
4) Mechanical Systems design and Engineering
5) Parachute Systems
6) Telemetry and Data Acquisition Systems
7) Technical Project Management

As an outcome of this round, the participating student teams shall be made to

1) Design, build and fly a Safe and stable scaled down amateur rocket to around 100m altitude.
2) A demo payload shall be safely mounted, carried to the altitude and separated from the rocket, after separation of the Nose cone. But it may be noted that the nosecone shall remain tethered to the rocket, and the entire rocket shall be landed safely by means of a deceleration system.
3) The spent vehicle shall land back between a fixed inner and outer radius from the launcher rail point.

As already mentioned in **Section 3**, this round shall be the second phase of progressive grading, where the teams will be graded following the PDR round.

Finances for the Hands-on Workshop, shall have to be borne by the respective teams. Each participating student from the team shall have to pay a Firm Fixed Course fee of ₹25,000/- (Rupees Twenty Five Thousand Only) per participant for participating in this workshop. It may be noted that each team can nominate a maximum of two participants. The participating students shall also be provided certificate after completion of the course.

The grading parameters along with the respective weightages, conduct of the workshop including the location(s) shall be declared in due course through ASI Website / direct e-mails / www.inspace.gov.in to all the participating teams.

8 Financials

The below are the financials for the competition. The teams may attempt for Sponsorship, and shall disclose the source of their finances in the Design Documents (PDR / CDR). The various payment phases, along with the Payment modalities shall be informed to the teams in the corresponding phases.

Sl No	Competition Phase	Amount	Remarks
1	Registration	₹5,000/-	All screened-in teams shall have to pay this amount

2	One-Week short-term skill development model rocketry course	₹25,000/-	• Firm Fixed Price / Participant • Two members per team envisaged to participate in this course
3	CDR Phase	₹25,000/-	At the time of CDR Submission
4	Cost of Motor	₹Cost / Motor	As per vendor

9 Requirements Compliance

The PDR/CDR document submitted by the teams shall contain a Requirements Compliance Matrix should be provided clearly as below. Any deviation should be clearly brought out, stating the reason thereof.

S. No	Requirement	Compliance
1.	**Basic Rocket Requirements**	
1.1	The lift off rocket mass must be within +/-5% of the design value. The overall length of the rocket as measured from the lowest to the highest points of the airframe structure (including fins) in launch configuration, shall be less than **180cm**.	
1.2	The teams may use Aluminum, Cardboard or PVC for the rocket body, and three various types of motors are envisaged to be provided by organizers. The body mass including Motor shall not be greater than 15Kg (Aluminum body), 10Kg (Cardboard body) and 11.5Kg (PVC body). The motor mass shall be around 3Kg. However, this requirement is subjected to change depending on the PDR reports provided by the teams. The Organizers may insist on standardizing the rocket body, depending on the number of applications for each rocket body type, Design calculations, etc.	
1.3	The provision for Bulkhead / Integration of Motor Compartment should be made available in the Rocket body.	
1.4	The teams shall design and bring their own launch pads, and the launch angle shall be in the range of 80^0 - 85^0. This shall be verified by the Jury Panel before giving clearance for launch.	

1.5	All parts of the rocket (other than disposable recovery wadding if any) must descend tethered together and must use parachute recovery.	
1.6	The rockets must have only one stage that shall be powered only by commercially-made model rocket motors, procured from Vendors identified and communicated by ASI.	
1.7	The rocket motor capacity designed by teams cannot exceed 2800 Newton-seconds of total impulse.	
1.8	Motors must be retained in the rocket during flight and at ejection by a positive mechanical means (clip, hook, screw-on cap, etc.) and not retained simply by friction fit in the motor mounting tube, but they must be removable post-flight.	
1.9	The payload Separation mechanism shall be developed by the teams for activation at the desired altitude.	
1.10	Any sharp edges on the container body shall be avoided as it can cause problems during the CANSAT ejection from the rocket.	
1.11	The body of the rocket structure shall be painted with fluorescent colors i.e., pink, red or orange.	
1.12	The Amateur Model Rocket shall consist of necessary sensors to provide the following mandatory Real-time datasets: Position data, altitude, pressure, temperature, orientation data, power data & system status.	
1.13	The data shall be displayed in near real-time on the ground station User Interface/Software.	
1.14	The Flight software system shall have provision to record the data and save it into an onboard SD card, in case of telemetry connection loss during flight.	

2.	**Payload Requirements**	
2.1	Rockets must contain and completely enclose in straight line configuration, a CAN-Sized satellite of diameter 0.15m and length 0.40m, with a weight of 1Kg +/-0.05Kg.	
2.2	The CANSAT (Payload) must be separated and deployed at the defined altitude (1000m +/- 100m).	
2.3	The vehicle, including the Rocket body and the CANSAT shall return safely to the ground by means of safe landing, using a deployable parachute.	
2.4	The CANSAT shall contain an altimeter and an accelerometer that will measure the altitude and acceleration levels reached by the vehicle.	
2.5	**Onboard Experiment Module (Optional)** • The experiment should be designed to operate autonomously during the rocket's flight. • Teams must include a detailed proposal outlining their experiment, including objectives, methodology, expected outcomes, and any relevant calculations or simulations along with the PDR submission, with basic guidelines to be considered, given below. • Technical Specifications • Safety Requirements	
3.	**Structural Requirements**	

3.1	The vehicle structure shall be built to survive 15g of launch acceleration & 30g of shock. a. All the structural margins of the Model Rocket shall be substantiated by theoretical calculation and Finite Element Analysis (as applicable) in the PDR / CDR documentation. b. Tri- axis accelerometers shall be mounted on the vehicle to derive the Inertial loads (g levels), that shall be plotted and submitted to the Jury. c. The Motor shall have sufficient margins to withstand the propulsive loads. d. The design calculations shall also substantiate the structural loads experienced on the vehicle including the joints and fasteners, as the case may be.	
3.2	Team number, email address and phone number must be placed on the structure in English, Hindi and the regional language of the launch state to aid in recovery.	
4.	**Avionics Systems**	
4.1	All electronics shall be enclosed and shielded from the environment. No electronics can be exposed except for sensors. There must be a structural enclosure.	
4.2	Electronic circuit boards must be hard mounted using proper mounts such as standoffs and screws. High-performance adhesives can also be used.	

4.3	**Power Requirements** ✓ The launcher ignition shall be carried out remotely, and accordingly an external power switch with an Indicator light or sound shall be provided. ✓ Battery capacity to support up to 30 Minutes of wait in on the launch pad with additional time for flight operations, shall be ensured. ✓ The battery source may be alkaline, Ni-Cad, Ni-MH or Lithium ion. Lithium polymer batteries are prohibited. Lithium cells must be manufactured with a metal package similar to 18650 cells. ✓ An easily accessible battery compartment must be included allowing batteries to be installed or removed in less than a minute and not require total disassembly of the Rocket / CANSAT mounted on the rocket. ✓ Spring contacts shall not be used for making electrical connections to batteries. Care must be taken as the shock forces can cause momentary disconnects of power.	

4.4	**On-board Communication Requirements** ✓ The Rocket communications radio shall be the XBEE / Zigbee radio series 1/2/pro. ✓ The XBEE radios shall have their NETID/PANID set to the team number. ✓ The XBEE radio can operate in any mode as long as it does not interfere with other XBEE radios.	
4.5	**Flight Software** ✓ The flight software shall maintain and telemeter an indicator of the flight software state. An example set of states is 0 (BOOT), 1 (TEST_MODE), 2 (LAUNCH_PAD), 3 (ASCENT), 4 (CANSAT_DEPLOY), 5 (DESCENT), 6 (AEROBREAK_RELEASE), and 7 (IMPACT). ✓ In the event of a processor reset during the mission, the flight software shall be able to determine the correct state. ✓ The states shall be described in the review presentation by each team.	
5.	**Ground Station**	

5.1	Each team shall develop and use their own ground station. All telemetry shall be displayed in near real-time during launch and descent. All telemetry shall be displayed in international system of units i.e., SI system. Teams shall plot data in real-time during flight.	
5.2	The ground station shall command the Model Rocket to start transmitting telemetry prior to launch. The rocket shall not transmit telemetry until commanded by the team.	
5.3	The teams shall ensure to have separate channels for rocket and CANSAT, with an interference test to be demonstrated to the Jury to avoid any overlapping between both.	
5.4	The teams can issue the telemetry command, only post the on-site inspection and clearance by the Jury members. A Pre-set checklist for clearance shall be made available for the teams, basis which the jury shall inspect and clear the vehicle for launch on the pad.	
5.5	The ground control station antenna shall be elevated from ground level to ensure adequate coverage and range.	
5.6	Stability of the ground station must be ensured.	
5.7	The ground station shall be able to command the rocket on parameters like barometric altitude, accelerometer readings etc, including zero-setting at the launch pad.	
5.8	The ground station shall generate .csv files of all sensor data as specified in the Telemetry Requirements section.	
5.9	Telemetry shall include mission time with one second or better resolution.	

5.10	In case of processor reset the mission clock/time stamp & system state shall be maintained.	
5.11	Teams shall plot each telemetry data field in real-time during flight.	
5.12	The ground station shall include one laptop computer with a minimum of two hours of battery operation, XBEE radio and a hand-held antenna.	
5.13	The ground station must be portable so the team can be positioned at the ground station operation site along the flight line and if required the team can also move to a different location, in case of distant landing location, in order to locate the projectile.	
6.	**Telemetry**	
6.1	Upon powering up, the Rocket shall collect the required telemetry at a 1 Hz sample rate or better. The telemetry data shall be transmitted with ASCII comma-separated fields followed by a carriage return in the format as given in the Annexure – 2	
6.2	The received telemetry for the entire mission shall be saved on the ground station computer as a comma-separated value (.csv) file that will be examined by the Jury post the flight. Teams will provide the file to the Jury immediately after the launch operations via USB drive. The .csv file shall include headers specifying each field of data.	
6.3	The telemetry parameters display format with resolution along with the file naming shall be as per Annexure - 2.	

7.	Descent and Recovery Requirements	
7.1	The Rocket shall contain a minimum of one descent control mechanism (parachutes) to be used at different stages while descent. It is the responsibility of the teams to ensure that both the rocket and the CANSAT descent safely and securely.	
7.2	The descent rate of the launcher body and payload bay shall be between 2 to 5 m/s (+/- 0.5 m/s). The descent rate should be measurable during the competition.	
7.3	The descent control system shall not use any hazardous chemical-based explosive or pyrotechnic devices.	
7.4	The descent control mechanism & all the attached components shall survive 30g of shock at the time of launch and separation.	
7.5	All the electronic components shall be enclosed and shielded from the environment with the exception of sensors.	
8	**Documentation Required**	
8.1	PDR Documentation with details as given in **6 DESIGN REVIEW DOCUMENTATION GUIDELINES**	
8.2	Participation in the One-Week short-term skill development model rocketry course	
8.3	CDR Documentation	

- State current design compliance to requirements
- Any deviation from the set design parameters is to be mentioned with proper reasons

10 Code of Ethics and Standards

The teams are advised to maintain high levels of ethics and standard during all times of the competition. Non compliances including, but not exclusive to those provided below, can lead to disqualification of teams from the competition:

- Copying any designs from any other competition / sources / competitors.
- Copying codes/ground station software.
- Submission of incomplete PDR/CDR documents.
- Any team not meeting the competition timelines.
- Teams found outsourcing the development.
- Usage of any restricted or hazardous chemicals etc.

NB: The decision of organizers will be final and binding on all the teams

11 Additional Information

- Teams will be notified regarding the launch location and the associated logistical availability at the location.
- Necessary regulatory clearances for the competition in general and launch in particular, shall be obtained by ASI
- A team may be provided only 1 launch opportunity in the Finals
- ASI is considering to conduct an Interaction session with the Screened-in teams to address any clarifications / queries that may arise during the interpretation of this document.
- The teams are advised to contact organizers through their faculty advisor via email / or ASI contact for start-ups, within 15 days of the release of this document, in case of any clarifications / queries that shall have to be addressed.

12 Selection of Motor provider

As covered in the document, the Teams may use either of the three Materials – Aluminum, PVC or Cardboard for their Model Rocket body. Accordingly, three configurations of Motor shall be made available by ASI through the vendor on cost basis.

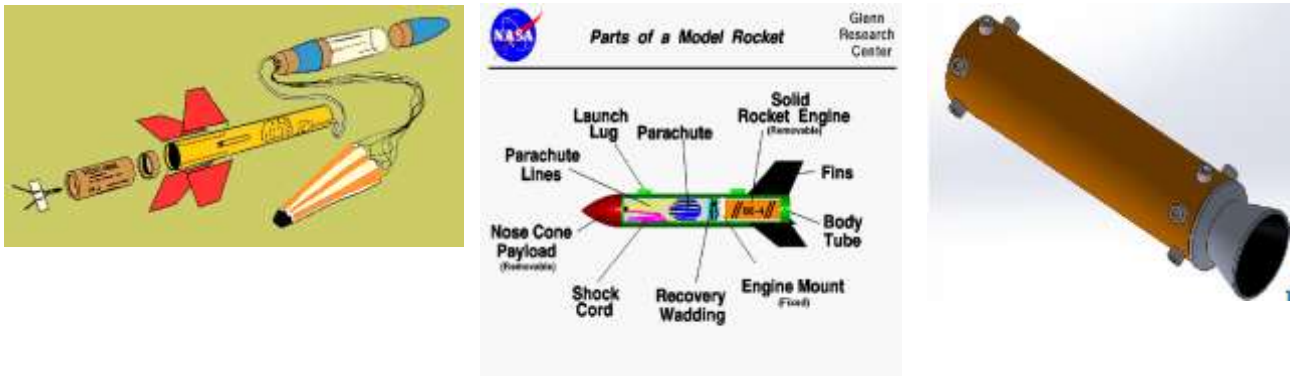
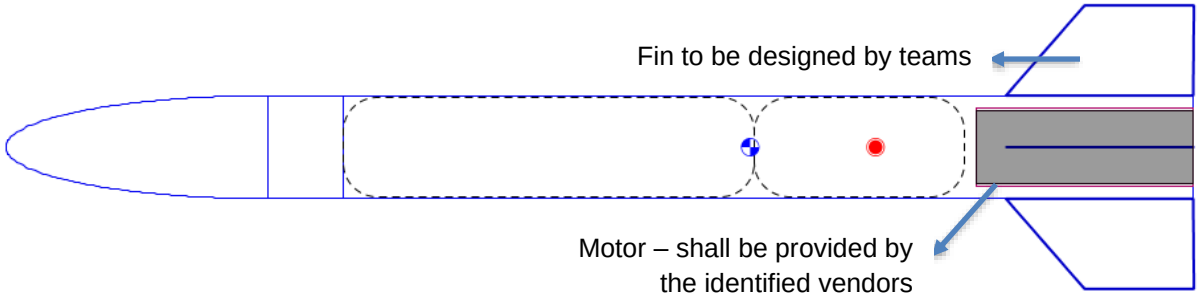


Figure 1: A typical Model rocket (Source: Internet, Internal References)

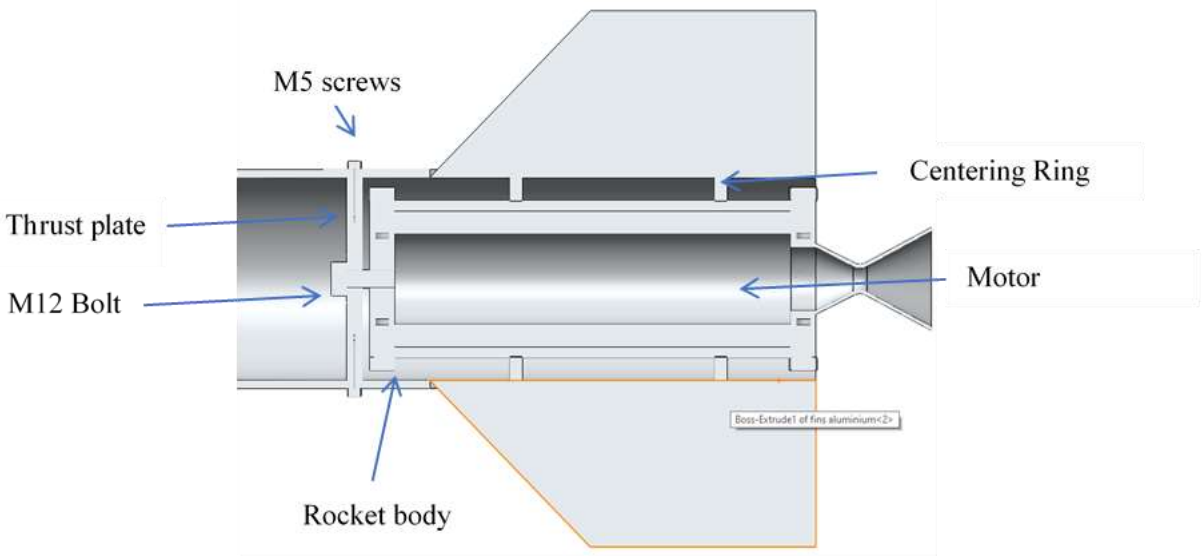


The standard motor that shall be provided along with the interfaces. The teams are free to use any of the three types of Materials and arrive at their configurations, and the same shall be matched with the three motor specifications. ***The teams shall calculate their own configurations along with the stability factors and submit in the PDR, accordingly the Motors shall be provided to the teams.***

<u>Interfaces between sounding rocket body and the motor</u> -

Motor will be aligned using centering rings, inner diameter of the centering rings would be determined by the diameter of the motor and the outer diameter of the centering ring will be determined by the inner diameter of the rocket body.

Thrust transfer from the motor to the rocket body will be done by using a thrust plate. Thrust plate would be attached to the rocket body using M5 screws and it would be attached to the motor using M12 bolt as shown in the figure below.



The motor dimensions (tentative) shall be as in the below table. Any modifications in the configurations / interfaces, shall be intimated to the teams.

Parameter	Aluminum	Cardboard	PVC
Motor Diameter	98mm	98mm	75mm
Motor Length	289mm	240mm	289mm
Fasteners	M12 bolts at the Thrust plate to Rocket body interface M5 Screws (6 No.s) to be match drilled between Rocket Body and Thrust Plate		

ASI shall engage with the Motor vendor ecosystem in India, and identify a list of up to 3 vendors, at a fixed rate. The participating teams shall mandatorily procure the motor from such identified vendors only, at a pre-fixed price.

13 Annexure-1: Guidelines for IN-SPACe Model Rockery Competition

1) The competition is open to all undergraduate students from Engineering / Science background enrolled in Indian colleges/universities

2) Applicants shall apply for the competition in teams and the team applying for the competition shall have a minimum of 5 members and shall not exceed 8 members.

3) Only 1 team is allowed per college/university. For colleges that are affiliated to a university one application from each of the affiliated colleges is allowed.

4) Additionally, the Undergraduate Student team can have 1 faculty coordinator/advisor and up to 2 mentors who could be the graduate students enrolled in the university's higher education courses *or* faculty *or* the alumni of the institution. If there is no mentor than the faculty coordinator/advisor shall act as mentor.

The role of the faculty coordinator/advisor is to:

- ✓ Act as a point of contact for the team, both with the university and ASI
- ✓ Assist teams with logistics such as arranging conference rooms, lab resources etc.
- ✓ Providing general guidance throughout the competition.
- ✓ The faculty advisor shall not make design decisions or direct recommendations or participate in more than an oversight role during reviews.

The role of the mentor is to:

- ✓ Act as a liaison between the team and the competition committee. The mentor will be responsible for scheduling all competition reviews and coordinating all communications with the team. Mentors are also responsible for tracking the team's progress throughout the competition.
- ✓ Team mentors shall be available to answer questions and provide general guidance.

- ✓ The mentor shall not provide design recommendations.

5) The team applying for the competition must provide an approval letter from the institution consisting of the details of all the team members including the name, Institute ID, course enrolled in branch, year of graduation and the role in the Team (roles can be defined as per the tasks assigned to the team members) on the institute's letterhead duly signed by the head of the institution. The scanned copy of the letter shall be attached with the registration form. (Approval letter template can be downloaded from IN-SPACe website: www.inspace.gov.in)

6) **Last Date to Apply**: June 30, 2024 *(Completed)*

7) In case of any changes in the team after the registration, an official request shall be made by the faculty coordinator/advisor regarding the same to director-pd@inspace.gov.in / asindia.org@gmail.com with a subject line: Team Change Request IN-SPACe Model Rocketry Competition. No change shall be permitted post PDR.

8) **Additional details**:

- ✓ After the registration timeline is complete, participants will be provided with a mission requirement document for the Model Rocketry competition, in due course.
- ✓ The participants will be required to submit preliminary design review document (PDR) along with a non-refundable participation fee of Rs. 5,000/- (Rupees Five Thousand Only), to be paid to Astronautical Society of India.
- ✓ The PDR qualified teams shall undergo a one-week IN-SPACe short-term skill development course on Model Rocketry. This course will have hands-on practical sessions to design, develop and launch the scaled down version of amateur model rockets. The registration and payment details for this course shall be communicated by IN-SPACe in due course of time. Only two participants will be permitted to attend this course per team.

- ✓ Post workshop, teams will have to pay a non-refundable fee of Rs. 25,000/- (Rupees Twenty-Five Thousand Only), to be payable to ASI India to participate further in the competition.

- ✓ Post the Model Rocketry Workshop, the participating teams will be required to submit a Comprehensive Design Review (CDR) document within a specified period. The teams shall keep in mind that the break-up of the costs of the rocket , including the development, material, test and validation cost, along with other applicable line items shall be included in the CDR document, and presented. The usage of “Make in India” components will be given due weightage during the evaluation.

- ✓ The CDR qualified teams shall be permitted to launch their rockets subject to successful completion of mission/flight readiness review. The organizing committee can undertake visits to the colleges / labs at any stage of the competition.

- ✓ After the CDR the jury will check the Launchers for the flight readiness during the Flight Readiness Review and launch dates will be given to the teams.

- ✓ In the final stage, rockets will be launched and after the Post Flight Analysis (PFA) of the launchers, along with physical inspection of the recovered launchers, winners shall be decided.

- ✓ The teams are advised to generate marketing pitches and collect sponsorships for participating in the competition. The sponsorship amounts such received, along with the cost break-up shall be included and presented during the Critical Design Review phase. The qualified teams’ details will be displayed on the IN-SPACe / ASI website.

- ✓ The details of the payload, along with the specific dimensions, and other requirements shall be included in the Mission Requirements and PDR Guideline Document that will be released in due course.

- **The tentative timeline for the Model rocketry India student competition is provided below:**

S.No.	Activity	Start Date	End Date
1.	Registration	06-06-2024	30-06-2024
2.	Mission Requirements and PDR documentation Guidelines Release	15-07-2024	15-08-2024
3.	PDR Document Submission	16-08-2024	30-09-2024
4.	Preliminary Design Review Completion	01-10-2024	31-10-2024
5.	Skill Development Workshop on Amateur Model Rocketry	01-11-2024	30-11-2024
6.	Critical Design Review Submission	01-12-2024	31-12-2024
7.	Critical Design Review	01-01-2025	31-01-2025
8.	Flight Readiness Review & Launch Window	01-04-2025	30-04-2025
9.	Post Flight Review and Results Declaration	After completion of Competition	

14 Annexure – 2: Telemetry Format and filenaming

I. Telemetry Format to be followed by the teams

<TEAM ID>, <TIME STAMPING>, <PACKET COUNT>, <ALTITUDE>, <PRESSURE>, <TEMP>, <VOLTAGE>, <GNSS TIME>, <GNSS LATITUDE>, <GNSS LONGITUDE>, <GNSS ALTITUDE>, <GNSS SATS>, <ACCELEROMETER DATA>, <GYRO SPIN RATE>, <FLIGHT SOFTWARE STATE>, <ANY OPTIONAL DATA>

II. Telemetry file naming format

Flight_<TEAM_ID>.csv. It is recommended the ground software produce this file, with the correct name, easily from the ground system user interface.

S. No.	TM Parameter	Function	Resolution /Format
1.	<TEAM ID>	Team Number	2024 ASI-XXX
2.	<TIME STAMPING>	Time since the initial power	Seconds
3.	<PACKET COUNT>	Count of transmitted packets	
4.	<ALTITUDE>	Altitude in units of meters and must be relative to ground	0.1 meters
5.	<PRESSURE>	Measurement of atmospheric pressure	1 pascal
6.	<TEMP>	Temperature in Celsius	0.1 ^{o} C
7.	<VOLTAGE>	Voltage of the CANSAT power bus	0.01 Volts
8.	<GNSS TIME>	Time generated by the GNSS receiver	Seconds
9.	<GNSS LATITUDE>	Latitude generated by the GNSS receiver	0.0001 degrees
10.	<GNSS LONGITUDE>	Longitude generated by the GNSS receiver	0.0001 degrees

11.	<GNSS ALTITUDE>	Altitude generated by the GNSS receiver	0.1 meters
12.	<GNSS SATS>	GNSS satellites connected	integer number
13.	<ACCELEROMETER DATA>	Data received from the gyroscopic sensor i.e acceleration and roll & pitch parameters	m/s2
14.	<GYRO SPIN RATE>	Spin rate of Mechanical Gyro wrt. CANSAT	deg/s
15.	<FLIGHT SOFTWARE STATE>	Operating state of the software	(Boot, idle, launch detect, deploy, etc.)
16.	<OPTIONAL DATA>	Any data coming from the optional mission objectives	

DOCUMENT CONTROL SHEET

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Approved by Chairman, Organizing Committee: Signature:

Approved by Executive Secretary, ASI: Signature: