

FAI Scale Space Models: Judges Introductory Guide



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Introduction

SCALE MODELS have been part of FAI Space Modelling since its inception in the 1960s. Two discrete scale classes have existed from the outset, S5-Scale Altitude and S7-Scale. The former is a performance class, flown under a defined propellant Specific Impulse, measured in Newton seconds (Ns), with Seniors using slightly bigger models than Juniors. Seniors fly on a higher Specific Impulse – 10Ns 'C' power: S5C; Juniors utilise 5Ns 'B' power: S5B. Both S5-Scale Altitude and S7-Scale are statically judged for scale adherence and quality, before being taken out and flown. The key difference is that S5 models have an *electronic Altimeter* (eAltimeter) fitted and are then boosted, with the achieved altitude in metres, being added to the judges' static score. S7-Scale is equivalent to FAI class F4-Scale, where prototypes are statically assessed, then taken out and flown, with the resulting flight score being added to the static total. The latter are routinely bigger and more sophisticated, but must weigh no more than 1500g and be boosted on less than 160Ns 'G' power.

Differences between *Aircraft* and *Rockets* need considering, >99.9% of the former evolved to carry *people*, from a single pilot, to hundreds of passengers; cruise missiles and drones the exceptions. *Rockets* are not 'people carriers'; exceptions include, *Vostok*, *Soyuz*, *N1*, *Energia-Buran* (former-Soviet Union & Russia); *Mercury Redstone*, *Atlas Friendship 7*, *Gemini Titan*, *Saturn 1B*, *Saturn 5*, *Space Shuttle* (United States) and *Shenzou* (China). The consequence is size related – 'orders of magnitude' - aircrafts' size focuses on *People*; rockets' size focuses on *Function*. Extreme example...the full-size *Saturn 5* moon rocket was >100m long and as wide as a dual carriageway! A real *Sako* anti-hail rocket, conceived to spray potassium iodide into freezing clouds is <30cm (~12 inches) long. These have featured in the World Cup; a 1:100 scale, 1 metre (39") long, *Saturn 5* and 1:1 scale, 30cm (~12") *Sako*, in recent times. Comparing different surface details can be a real challenge. In addition, aircraft are designed to be used again and again, rockets are generally boosted once, before digging their own grave, or splashing down! The *Space Shuttle* was 'reusable', with the orbiter and solid rocket boosters being recovered and refurbished...but the main fuel tank always needed to be replaced. This is a challenge for scale Space Modellers, as it's practically impossible to find a full-size prototype that's actually flown.

A review of judging parameters – for Static and Flight Judging – is provided below and also a brief tour of the 'Rule Book' – *FAI Sporting Code, Section 4 - Aeromodelling, Volume S, Space Models* (FAI Sporting Code).

Basics ~ Time to identify key sections of the FAI Sporting Code. The list below is comprehensive, containing key information needed to judge S7-Scale and S5-Scale Altitude; the former much more common. Reading through all relevant sections is recommended.



That's what the judging hall looks like at a World or European Championship for Juniors & Seniors. Toughest week of the year for the Judge. Always a good coordination is needed here ... from setting up the "judging hall" to managing the logistics to ensure that all results are processed on time.

S7-Scale ~ FAI Sporting Code: Part 9 Scale Competition (Class S7)

- Defines *single* and *multi staging*
- Defines *prototype selection* and *proof of scale*
- Defines use of '*kit parts*', additional *stabiliser fins*, plus *weight* and *impulse*
- Defines *Documentation*, *Adherence to Scale*, *Degree of Difficulty*, *Workmanship*, *Flight Characteristics*, plus *Measuring Team* appointments at Major Championships
- *Maximum weight* – 1500g and propellant *Specific Impulse* – 160Ns and maximum motor size – 80Ns is specified, but not normally relevant

S5-Scale Altitude ~ FAI Sporting Code: Part Two Space Model Specifications

- Defines *S5B* and *S5C dimensions*
- Defines current parameters for *S5 prototype selection*
- S5 is normally only flown at Class 1 World and Continental Championships; occasionally at National Championships, too.

FAI Sporting Code: Part Ten Scale Altitude Competition (Class S5)

- Defines all contest rules and possible DQ parameters
- Maximum weight of a prototype is specified, but not normally relevant



Scale Modelling is all about the documentation. Here, V-5-V Vertikal sits atop a scale drawing, with documentation adjacent. A simple model but still has plenty of external components and detailing to stack up the score. Almost sure to score 40 points 'Originality', but only a single-staged rocket that will score fairly low on the field, despite SFX, like satellite launching; very realistic slow launch, with lots of smoke and a number of parachutes and streamers.

Static Judging ~ Judges are much more likely to be called upon to assess S7-Scale models; S5-Scale Altitude events much less common, outside of FAI Class 1 – World & Continental Championships. However, S5-Scale Altitude and S7-Scale models are judged in the same way. **The concept of assessing a rocket prototype focuses on the Documentation submitted by the competitor.** The scale of the models must be clearly displayed, such that *Scale Adherence* can be determined. Judges should try and ascertain that the entrant is the 'builder of the model', although in practice, this is very difficult.

Static Judging implies good analytical skills, an 'eye for detail' and a familiarity with the complications arising from comparisons between *three dimensional* objects and the *two dimensional* photographs & drawings submitted. **In addition, judges must also disregard any prior, or specialist, knowledge they may have of a specific full size prototype or the modeller's previous work.** In order to make an accurate assessment of the craftsmanship involved, judges need a good understanding - preferably practical experience - of the skills, materials and processes involved in the construction and finishing of flying scale space models. Innovation - such as 3-dimensional printing - is changing the manner many scale models are detailed.

Judges' Guidance FAI Sporting Code: Annex 1 Scale Modelling Judge's Guide

- Defines Competitors' details: *Name, FAI number, Competitor number, National team, Model prototype Name/Serial number* and possible DQs
- Defines how to assess completeness of Scale models' *Documentation* packs
- Defines '*Degree of Difficulty*' and what to look for
- Defines '*Scale Adherence*' and how to deduct points for % errors in scale
- Defines '*Workmanship*' and '*Paint Finish*' and how to award points objectively
- Defines the '*Originality*' rule and the award of bonus 40 and 20 points
- Defines how to judge *Flight Characteristics* and '*Realism*'

FAI Sporting Code: Annex 2 Space Modelling Judges and Organisers' guide:

- Defines the role of Scale judges at World Cups and Major Championships
- Defines how Judges, RSOs and Organisers interact at events
- Defines DQs, catastrophic failures, 'Crash of Engine', instability, unsafe recovery etc

Degree of Difficulty (DofD). To what degree does the rocket depart from the configuration of a cone-topped cylinder, with fins? How complex are the entry's external features? **Consider the number of external features and detailing, like panels, corrugations, antennae et al.** How complex is the paint scheme? Similarly, how complex are the entry's markings and lettering? How difficult was it to adapt the entry to enable reliable flight characteristics? These items are the key to DofD. More detail is to be found in Annex 1 of the FAI Sporting Code.



Image left: A collection of various prototypes with different paint pattern, configuration, external components, detailing and flyability. Always a good start for the judges have a briefing and set judging criteria for all classes - DofD, Workmanship and Finish - before judging separately. Remember, like the judging hall is always different, so the final score varies.

Image right: Three Meteor 1 sounding rocket prototypes are shown. Model far-right employs the bigger and more sophisticated 'dart' top section. However, those two probably had the booster sections built by the same modeler...finish and graphics virtually identical. Model far left, is clearly different...paintwork more deeply applied and the graphics denser and emboldened. Some modelers focus on the overall build, some on the details, what's for sure is that 'identical' prototypes don't always become identical models.

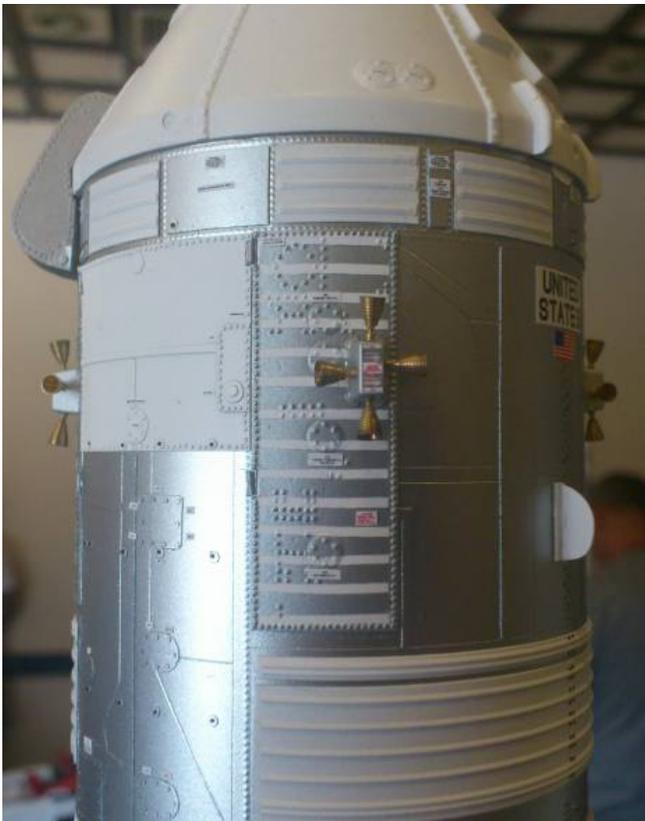
Related to the above, many judges assemble a '*Degree of Difficulty*' chart, listing criterions how to award points for each sub-class. Although a starting point at each new event, it ensures that a consistent start is made; deviations relevant if configuration, external components, details and paintwork differ. Essential here, always judge the entry as it would be the first time, and judge "step by step" through each sub-class. A novel rule – '*Originality*' – has been introduced to improve diversity in entries, both in S5-Scale Altitude and S7-Scale. A unique prototype in a contest scores a bonus 40 points, if there are only two examples, 20 points each. Judges need to

be aware that if there are discrete Seniors and Juniors' contests, Originality applies to each, for example, if there are 3 identical prototypes in Seniors and 1 in Juniors, the former all score Zero and the Juniors' example scores 40.



Image left: Interkosmos on display with its 'cousin', the V-5-V Vertikal. Interkosmos is basically a parallel tube, but the surface detailing and multi-colored Paint Pattern improves its Degree of Difficulty score. At the bottom of the table is a BAJ Skua.

Image right: Paint finish...sometimes glossy and matt paint effects come together, like on this ABRIXAS Interkosmos prototype. Note also the 'Duct tape' over the removable covers on the main body, lots of detailing shown here. Degree of Difficulty: Interkosmos is a prototype that will score low for Configuration - being just a parallel tube with a simple nosecone and cone end. However, if properly manufactured, External Components and Detailing scores will be high with lots of surface components, rivets etc. And the Paint Pattern -depending on the prototype in question - can be complex and with lots of colors and surface finish effects.



Saturn 1B prototypes have a potential to score a high Degree of Difficulty and the capsule launching section shown mirrors this. Lots of micro-detail, but are those rivets - especially the black ones - too prominent? Also, the quad-nozzles should be hollow, not solid as it is the case on the image right. Although identical number of details, different "complexity factors" need to be applied to both scale models.

Scale Adherence Dimensional measurements – overall length, nosecone length, major body diameter, first stage length, fin span etc. are made by the measuring team, at major events. At smaller events, the judges may have to measure the models and calculate *Scale Adherence*. It is better for one judge to be given responsibility for this. Each 1% deviation results in a 2 point deduction. In addition, comparison of a model's colour scheme to the images provided; similarly, markings – lettering and insignia.

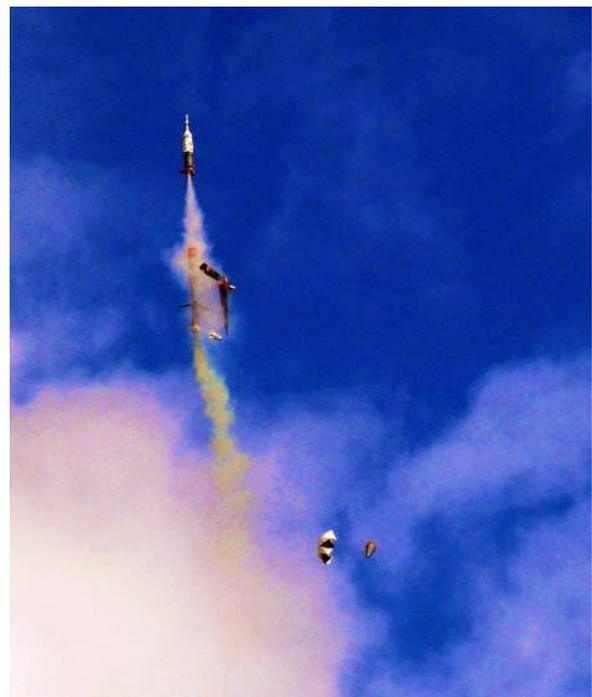
Workmanship How well is it made? Scan the model from nosecone & transitions, body, fins/stabilisers and details. Are the edges sharp as they should be? Are glue joints visible? How well is it finished? Is the paint texture correct – is it glossy when it should be matt? ...is there dust in the paint? ...are colour demarcations crisp?

Judges must be aware that the models scrutinised in the hall, are the ones that must be employed to make the qualification flight. An ultraviolet (UV) pen, applied during judging, enables the model to be identified when presented for flight. Alternatives to a UV pen & sensor, are unique stickers applied to parts of the models. Care should be taken regarding the placement of the latter, such that cosmetic damage does not occur when subsequently removed. Illegal substitution of a model may occur, but it's fairly uncommon.

Flight Judging ~ In contrast to Static Judging, assessment of the quality of an S7-Scale rocket's launch and flight profile is based on prior knowledge of the full-sized prototype's boost characteristics. Consequently, an understanding of the performance and limitations applicable to different generics of full size rockets, depending upon their design requirements, is implied. However, it is inevitable that judges will have to assess the flights of rockets of which they have little knowledge of and consequently some assumptions regarding performance will be necessary. To optimise their assessments, judges are encouraged to expand their knowledge and studying historic films and relevant documents. It is also important for judges to do their 'homework', in order to be able to judge a replica of an unfamiliar prototype. Most S7-Scale space models boost away too quickly, by comparison to the full-size rocket and should be marked down accordingly. Naturally, most sounding rockets accelerate quickly off the launcher and it is possible for a higher score to be awarded for these than a Saturn 5 moon rocket which does the same.



The flight itself is the essence of any flight judging.



A straight boost ensures high points.

Stages / Powered Separations – Novel words in the FAI Sporting Code have replaced the term, ‘Staging’, with Powered Separation. The reason is that it is now also possible to launch a powered spacecraft, but relevant data needs to be presented to prove that it was powered. This ensures no “doubts” how a “stage” is defined by different sources. Scoring is up to 30 points per powered separation, to allow for an ‘imperfect’ separation process. With the flight scores now forming a greater part of the total score, the number of powered, separated parts a specific prototype possesses forms a critical factor. Remember, it is the full-size prototype’s engine alignment which must be considered here.

Plenty more prototypes feature in a typical S7-Scale judging hall, including former S5-Scale Altitude models, like *Bumper WAC*, *Taurus Tomahawk...Cajun...Apache* etc ~ 1 powered separation: up to 30 points, which are no longer flown under the current rules of S5.

Relevant to this is:

FAI Sporting Code 2.3 STAGES OF OPERATION, 2.3.1 *There shall be no more than three (3) operable stages....Engines ignited simultaneously are considered one stage regardless of the number of separated parts; for example Soyuz.*

Multi-staged prototypes may be flown single staged – scoring zero for powered separation - and scored accordingly for realism of launch and boost profiles, especially if the weather is poor.

Special Effects (SFX) – SFX embrace a wide range of features – which *must* have taken place on the full-size prototype. A list includes the following:

- separating powered boosters
- separating unpowered boosters
- fairing deployment
- interstage separation
- unpowered satellite deployment and each additional satellite (which must be documented in the scale data)
- launch smoke (in addition to the motors’ ignition smoke)
- realistic countdown, employing radio recordings of the real rocket’s launch
- scale launcher, depending on its complexity and functionality: may be static, or fully functional and realistic to scale

Typically, more complex SFX can be scored up to 15; simpler SFX like smoke generation should score 5 points. At the time of writing this guide, this is how judges should proceed. Naturally, shedding of boosters, by *Soyuz*, *Space Shuttle* and *Energia Buran*, for example, will count as a *Special Effect* and score the highest amount of points.

A model brought to the judges’ table for check-in pre-flight, needs the following determined:

- Confirm that the model is the *same* prototype judged in the hall
- Determine *how many motors* the model will employ during flight
- Determine *how many powered separations* will occur during the flight
- Determine details of *Special Effects* (SFX) that will be employed
- Determine details of *how many parachutes* and *streamers* will be deployed

With this information, judges should use *FAI Sporting Code: Annex 1* to compile sub-totals of the potential flight score and record in the Flight Book. When the RSO counts down for the launch, prepare to judge the realism of:

- *SFX* in the final seconds of countdown
- *Realism* in the initial phase of the launch
- *Realism* of the whole boost profile, determining that declared powered separation and *SFX* take place as described, to the point of ejection of recovery systems

- *Number of parachutes and streamers* employed in the recovery process
- Record the sub-totals in the Flight Book

...these scores should be combined with the sub-totals previously obtained and confirmed when model components are returned to the Judges' table to enable confirmation that all motors have functioned. Score deductions must be made if one or more motors are unlit. The scores should be recorded on the competitor's flight card and given to the Chief Judge, so they can be layered into the other judges' data and averaged. When judging flights, it must be remembered that only the RSO, or deputies, may disqualify a flight and a flight that is DQ'd must still be scored, in case the decision is reversed. S7-Scale judging is completed when the mean *static judging scores* are added to the *mean flight scores*. The higher the total score determines competitors' ranking. Naturally, flights of class S5-Scale Altitude are not assessed by the judging team, only the eAltimeter score in metres, ranks the flights. Flight score, in metres added to the static score.

Basic Needs ~ Prospective S5-Scale Altitude and S7-Scale judges require the following:

- FAI Sporting Code, current edition
- Measuring kit, to include a tape measure, rulers – in both Metric and Imperial units and calipers
- Pens, pencils and erasers
- Calculator
- 'Flight Book' to take out to the field and record details of S7-Scale models pre-flight, number of motors, stages, SFX, parachutes, streamers etc.

Coaching and appointment of junior judges ~ practicality comes into play as there are too few people willing to take up this task, ideally:

- Inexperienced 'junior' judges should start at domestic competitions
- Evolution to World Cup judging, in the company of experts, is the next stage
- Inexperienced judges may judge with experts and their scores compared with – but not included – in the contest scores, in the early stages
- As experience and expertise increases, National Aeroclubs should consider their inclusion on the FAI-CIAM Judges S list

Experienced judges may observe their junior counterparts whilst Static judging – often it is best for the judges to work as a team, enabling less experienced personnel to absorb the knowledge of their expert counterparts. At Class 1 Major Championships, all five judges must work independently and then submit their scores, where the highest and lowest will be discarded, the middle three totalled and a mean score determined.

Summary ~ Consistency is the most important attribute of a Scale judge. A Scale Judge has always to have consistent criteria for judging. Remember, a modeller has spent hundreds or thousands of hours to manufacture. As a modeller improves, so the model improves together with him. Also presented Documentation can change. ***As stated earlier, judges must disregard any prior, or specialist, knowledge they may have of a specific full size prototype or the modeller's previous work.*** A 'Degree of Difficulty' chart, listing judging criteria for each subclass is a good point for consistency. A key objective in scale judging is to reduce the subjective elements of the role, as much as possible. A greater emphasis of flight scores in S7-Scale has resulted in more multistage prototypes in Major Champs' entries. Recent rules changes have made the role more challenging, particularly in class S5-Scale Altitude, as *Originality* has resulted in a much more diverse range of prototypes on show. A focal judge's attribute is the willingness and ability to learn something new, every time a judging assignment is undertaken. Worth it, because scale Space Modelling is FANTASTIC!

Scale Space Model Judges' Introductory Guide

Annex 1

Basic Definitions

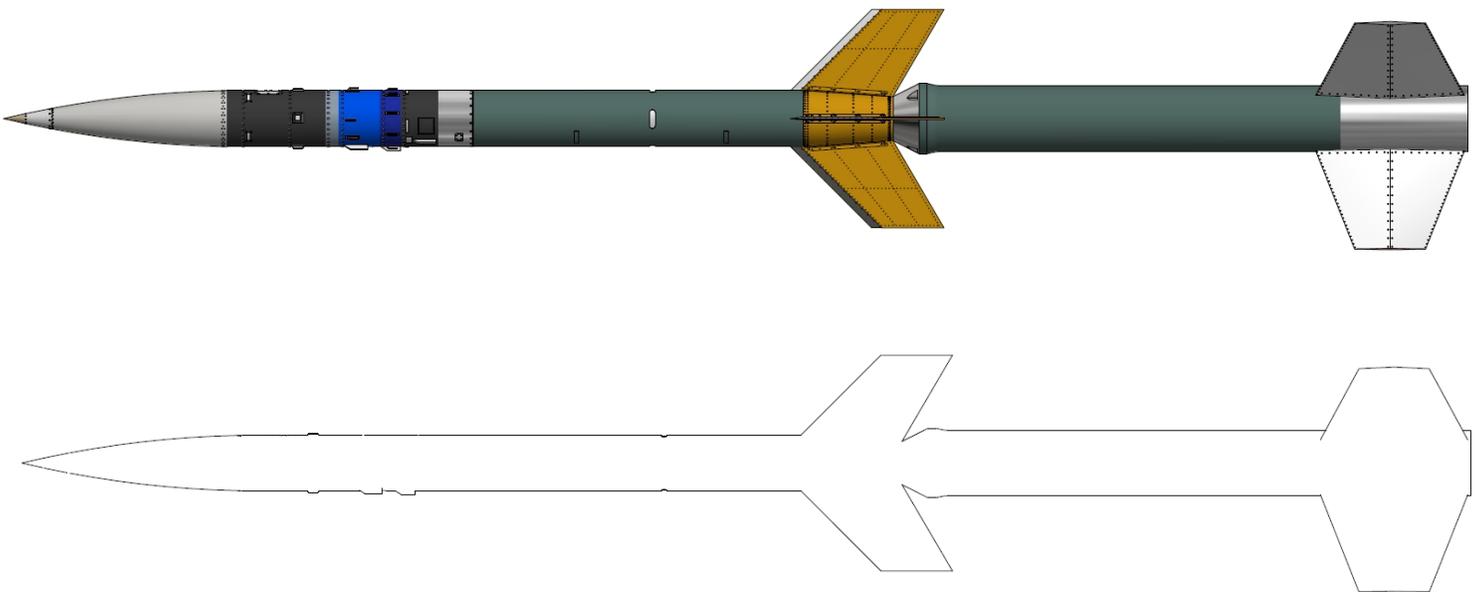
Main definitions:

Prototype: is the real-life basis on which the modeller's entry was manufactured. It is also the first sub-category of a rocket family.

Entry: represents the presented scale model in competition.

Definitions regarding Degree of Difficulty:

Configuration: represents the complexity of the main outline of the prototype/ entry with considered external components. Here to be considered to what extent does the outline change (number of different diameters) in contrast to a "properly sharpened pencil".

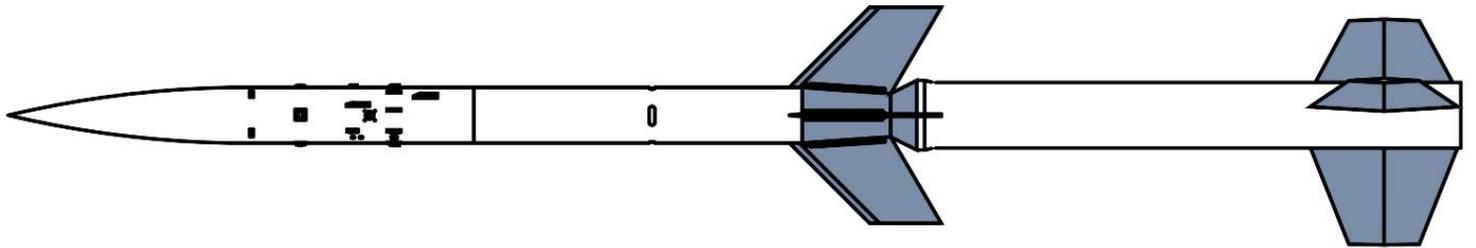
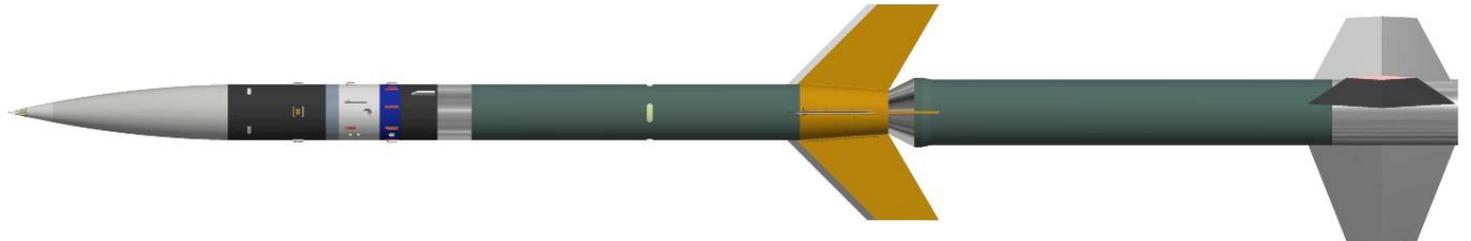


Example: "Outline Form"

Central Airframe: the main/bearing part of the prototype/entry.

External Components: are all components beside the core/ main airframe of the prototype/entry. Those include:

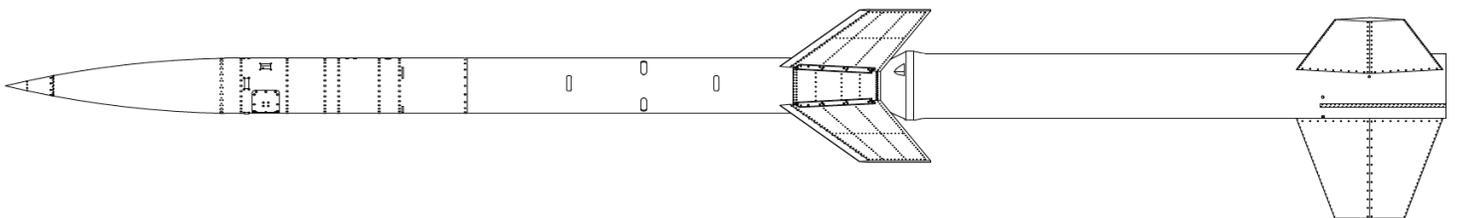
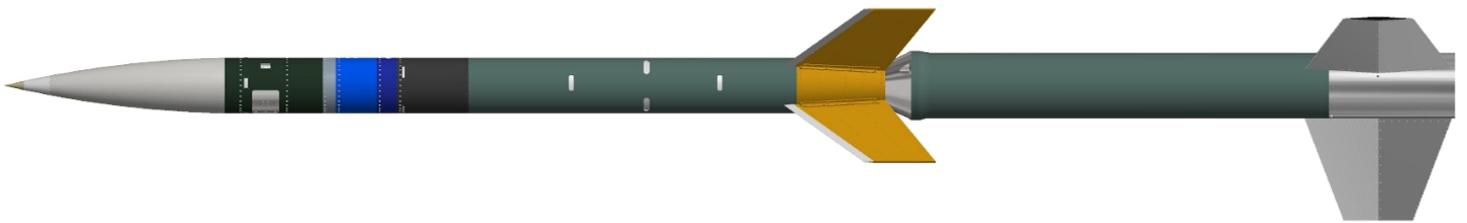
- Fins
- All transitions (also included on the central airframe)
- Interstage adapters
- Antennae's
- Strap on boosters
- Launch lugs



Example: "External Components"

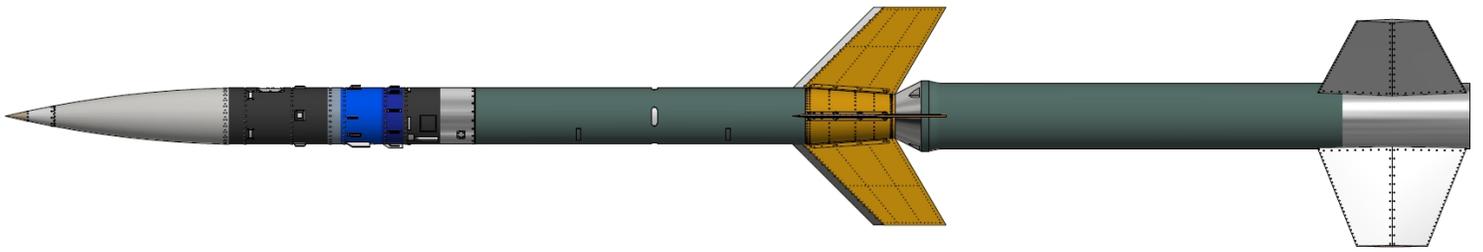
Detailing/ details: components enhancing the surface texture of the central airframe/external components of the prototype entry. Those include:

- Nuts
- Bolts
- Hatches
- Panels
- Corrugations
- Stringers
- Welds



Example: "Detailing & Details"

Paint Pattern: Overall quantity and complexity of colours and markings present on the entry.



Example: "Colors & Complexity of Paint Pattern"

Flyability: difficulty adapting the entry to make a qualified flight.

Originality: bonus points awarded for total quantity of identical prototypes.

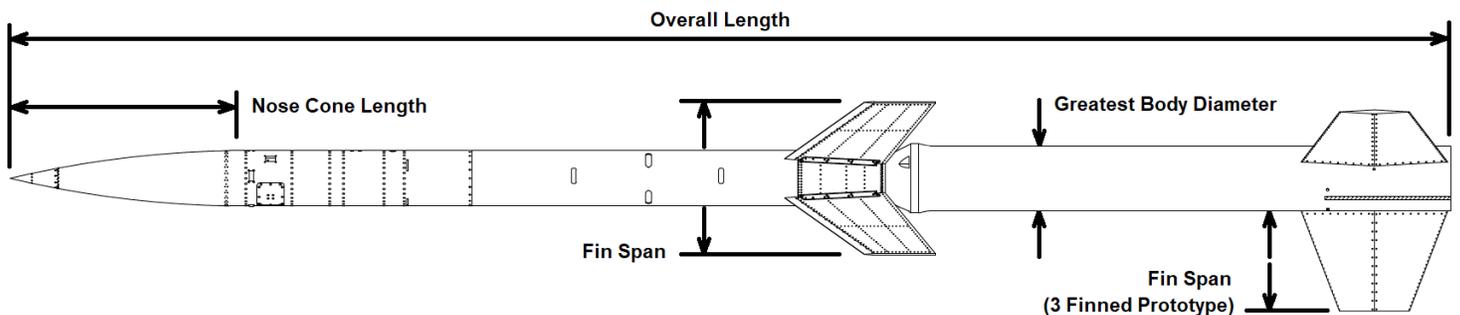
Definitions regarding Dimensions:

Overall model length: the largest measurable dimension of the entry's roll axis

Nose cone length: length of the forward section of the entry to the nearest stage intersection.

Greatest measurable diameter: largest accessible diameter to measure.

Fin span: largest dimension between two opposite fin ends; Or width of one fin on 3 finned prototypes.



Example: "Major Dimensions"