CanSat France

Competition Rules

4th edition (19.11.2010)

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Introduction

The idea of the CanSat competition was born in the USA during a meeting in Hawaii in November 1998. From the beginning the competition has been very popular with students. Since then, the event has spread all over the world, in Japan and Argentina and has finally reached Europe through Spain, the Netherlands, and now France.

The principle of CanSat is to build a small satellite inside a very restrictive volume: 33cL for the International Class and 1L for the Open Class competition.

A CanSat is an autonomous device able to accomplish one or several practical missions. Released from a given altitude, its goal is to carry out scientific or technical experiments. All the elementary functions of a satellite, such as power supply or communication systems, have to be inserted inside the can. For all students interested in space design and realization, this project is a tremendous way to learn about such equipments.

One of the most famous experiments is the Come-back mission that aims at autonomously steering the CanSat onto a target on ground defined by GPS coordinates.

The ambition of the CanSat competition is to get students fully involved in a real technical project and show them all the stages of such a program: design of the mission, preliminary and final design reports, technical certification, launching campaigns, experience feedback, etc.

This competition is opened to every secondary school pupil or student, whatever the school record (university, technical or engineering school).

The 3 or 4 day competition gather all participants on a dedicated launch area, with representative from CNES, Planète Sciences and space industry.

All relevant information needed will be regularly updated on the CanSat France website.

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1. Foreword

The present document contains the rules of the CanSat France competition organized by Planète Sciences and CNES (French national space agency).

The schedule and all missions of the current year are detailed in a document entitled « Proposed missions schedule » available on the website.

This document describes and explains the requirements of the rules.

The requirements are numbered and framed. Further information can be found outside the frames when needed.

2. Glossary

CanSat: within CanSat France framework, a CanSat is a miniature space-probe, with a volume comprised between 33 cL and 1 liter; the probe contains equipments to perform missions.

Organization: members from CNES and Planète Sciences involved in the preparation of the competition.

Technical committee: composed of members from CNES and Planète Sciences (and possibly professionals from the industrial world). This group is responsible for the technical follow-up of the CanSat projects. More especially, the group collects the deliverables from the teams and attends to the project review meetings. This group is led by par Planète Sciences.

Jury: composed of members from CNES, professionals from the space industry, the President of Planète Sciences and the leader of the Technical Committee. The Jury is gathering during the competition in order to evaluate the quality of the projects and to decide the awards.

3. Changes

1st edition: Creation of the document

2nd edition: 2009 competition version

3rd edition: 2010 competition version

- Chapter « Changes » added
- Nota on page 15 about the launching position added
- Nota about meteorological data added
- PLA001 updated
- PLA002 updated
- PLA004 created
- PLA005 updated
- PLA006 updated
- PLA009 updated
- CDC003 corrected : the height is 115mm and not 150mm
- CDC016 updated
- CDC017 updated
- CDC018 updated
- OP002, OP003, OP005, OP006 corrected

4th edition: 2011 competition version

- EQU002 modified
- PLA003 modified
- PLA004 removed
- PLA005, PLA006, PLA007, PLA008, PLA009 numbering corrected
- CDC001 updated
- CDC021 updated

4. Teams formation

All the participants must be organized in teams.

[EQU001]

Each team is composed of 3 people at least.

The number of participants is unlimited. A participant cannot belong to more than one team. Each team member must have a precise role in the group. Those roles must be defined inside the team's mission program. Each team must fill a registration form in which are indicated the name of the team, a picture of the team members, the name of the team leader and the name of the team member in charge of the communication between the team and the organization. The team must then send the registration form should be sent to the organization.

[EQU002]

Each team member should be secondary school pupil or student, or young graduated student, if he graduated within the year before the date of the competition.

People who do not meet those requirements can submit a project file to the organization. Once analyzed, if the project is validated, they will be allowed to launch their CanSat during the flight demonstration, but they will not be allowed to take part in the competition.

[EQU003]

A team can gather members from different schools or universities.

One school or university is allowed to have several teams, as long as the teams submit different projects.

[EQU004]

The team which receives some help from a professional person should mention it in the registration form.

This support person is invited to attend to the competition.

The organization strongly recommends, especially for new teams, to be sponsored by a teacher. This person would make connection easier between the organization and the school or university; he is invited to attend to the competition.

5. Competition sequence

[PLA001]

In order to take part in every phase of the program, each team must send a registration form to the organization in order to be added to the list of participants and to be allowed to join the competition. No team will be selected after the registration deadline (T0 milestone).

The CanSat competition was thought to be a realistic simulation of a space program involving landers onto celestial bodies. Therefore the competition sequence is split up in 4 parts: Design / Realization / In flight demonstration / Experience feedback.

The competition will be composed of several phases. Each phase yields a certain amount of points. At the end the teams are ranked according to their final score.

During the competition, each team will present its project to the jury, just before the flight demonstration.

After the flights, the results analysis will be presented to the jury as well. Those presentations will be taken into account by the jury to establish the final score.

Phase 1: Design

[PLA002]

The first document that teams have to write is the preliminary design report. This document is a PowerPoint-like presentation, with no more than 10 slides, and must contain at least:

- A technical presentation of the project;
- The missions chosen by the team, (*cf. document « Proposed missions schedule »*);
- A projected budget;
- Emission channels and associated emission powers, (*cf. CDC017*);

It is sent by email at cansat@planete-sciences.org with acknowledgment of receipt.

The deadline of the submission in the T1 milestone defined the program of missions of the current year.

This document is a detailed specification report of the CanSat design. It includes a description of the experiments carried out on board (free and imposed missions), projected budget and work plan of the CanSat project. Asking for such a document is a way to make sure that all the teams have well understood the scope of the competition and that their projects fulfill the requirements.

The organization selects teams qualified for the next steps of the competition. Then the technical committee review the documents sent by the selected teams, and give back to them their comments and advices to guarantee the CanSat conformity with the present rules.

A month after the T1 Milestone, all the selected teams are invited to attend to the design meeting, in order to present their preliminary report to the organization and to the other teams. This review is also an opportunity for participants to meet the other teams and exchange information of any kind.

[PLA003]

The second document that teams have to write is the final design report. This document is like a scientific paper and shall include:

- The context of development of the project (human, material, financier means of the team)
- The detailed design of each mission.

It is sent by email at cansat@planete-sciences.org with acknowledgment of receipt.

The deadline of submission is the T2 milestone defined in the program of missions of the current year.

Two months before the T2 milestone, a document template for the second deliverable is provided by the organization and available on line.

The final design report is given to the jury members so that they can evaluate project originality and quality taking into account the associated budget and external collaborations.

The deliverable document yields point according to the evaluation score table in annex of the document "Proposed missions Schedule" on the current year.

Phase 2: Realization

Nota: *This phase occurs only if the team has passed the selection process from the preliminary report.*

The second stage of the program is the realization of the Cansat, after validation of the preliminary design report.

[PLA004]

All physical data collected by the Cansat will have to be transmitted to the ground by telemetry and recorded by the team for a later exploitation.

[PLA005]

The CanSat will have to fulfill all requirements of the program specifications (*cf. §7*).

A check point is organized the day before the operation to test the conformity of the Cansat. The success of the key step results in the authorization for flight.

Phase 3: Project presentation

[PLA006]

Each team makes a 10-minute PowerPoint-like presentation. It is followed by 5-minute questions from the jury.

During this presentation, teams describe the objectives of their missions and how they intend to achieve them. These are some points to address:

- Mission objective
- Technical review of the CanSat (design, realization, tests, validation)
- Planning /costs

This oral report is also the opportunity for the teams to have a better overview of all the projects in competition.

The presentation yields points according to the evaluation score table in annex of the document “Proposed missions Schedule” on the current year.

Phase 4: Flight demonstration

The CanSat is released from a tethered balloon during a event gathering all the teams and organized by the Planète Sciences association and CNES. The initial velocity of the balloon is close to zero.

[PLA007]

Imposed and free missions are realized after the release of the CanSat from the balloon interface.

Each team must record data of his missions in order to make an analysis and a synthesis that will be presented later. Each mission is evaluated according to the corresponding score table. A special score for the Come-back mission is given to the teams whose CanSat steer as close as possible to the target.

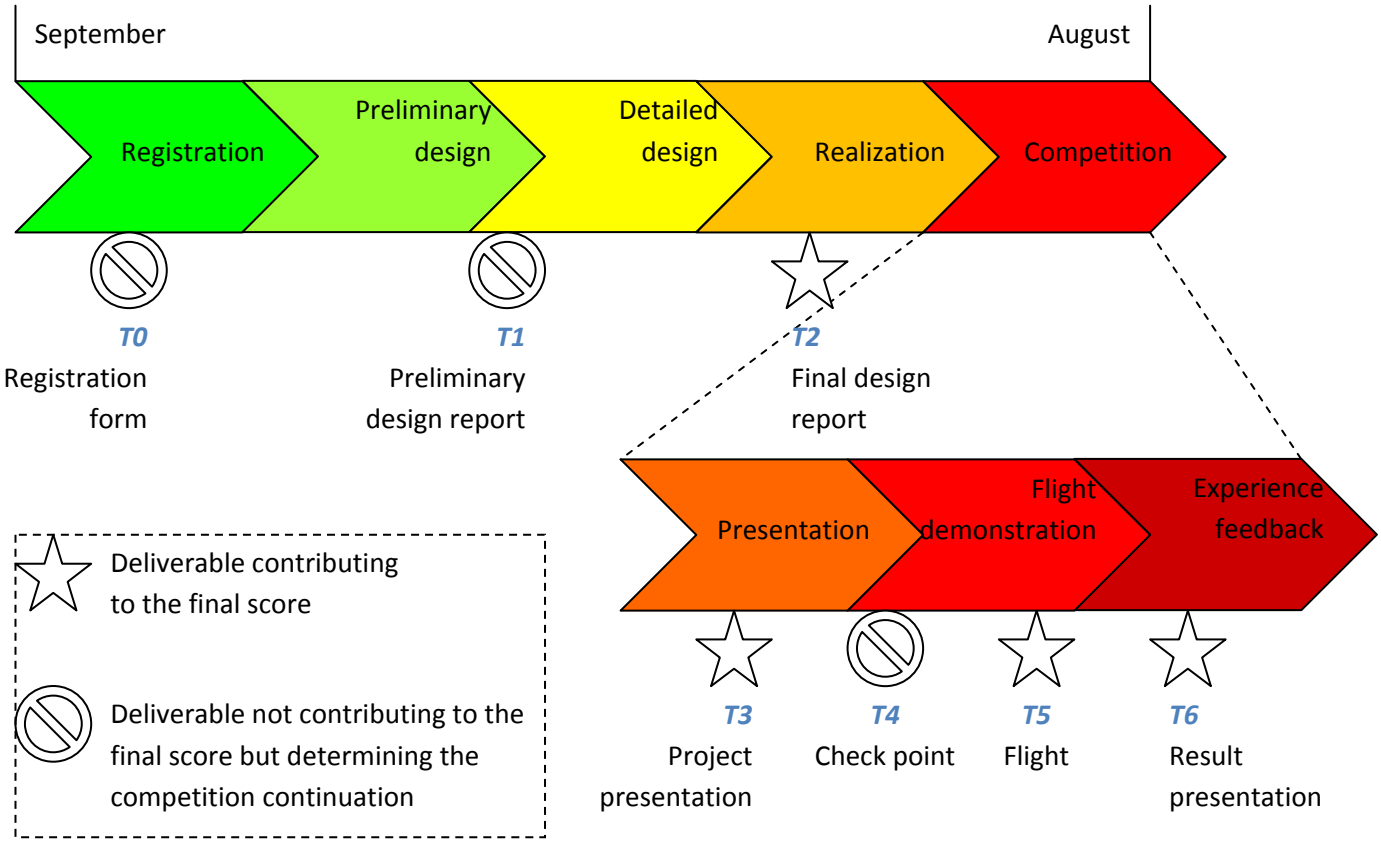
Phase 5: Experience feedback

[PLA008]

The last stage of the competition is a presentation of experimental results and global analysis of the project to conclude on the work performed during the year.

The oral report is open to a large audience and aims at presenting scientific (flight result interpretation), technical (critical view of successes and failures) and organizational (compliance with planning) analysis to give a complete experience feedback of the project. The talk must not exceed 15 minutes.

Synthesis of the program phases



The phases take place during a full school year, typically from September to summer. Precise dates are given in the "Proposed missions schedule" document.

Synthesis of the program milestones

Calendar	Event	Deliverable	Remarks
Before the competition			
T0 Milestone	Registration closure	Registration form	On-line form Acknowlegment of receipt from the organization
T1 Milestone	Preliminary design report delivery	PowerPoint-like presentation	Project Selection 10 slides maximum
T2 Milestone	Final design report delivery	Scientific paper	Electronic version, template provided by the organization, 8 pages maximum Used by the technical committee for: - Project evaluation - Security aspects
During the competition			
T3 Milestone	Project presentation	PowerPoint- like presentation	10´ presentation + 5' questions
T4 Milestone	Check point		Check list provided by the organization
T5 Milestone	Flight demonstration		
T6 Milestone	Experience feedback presentation	PowerPoint- like presentation	15' maximum

6. Missions

Nota:

CanSat Missions are realized during the descent phase but also possibly after landing (like planetary landers).

Mission definition

Scientific mission: The goal is to measure any parameters belonging to the environment of the probe: temperature, sun radiation, ground characteristics. This implies on board transducers and telemetry link with a ground station.

The degree of innovation of the proposed technologies will be taken into account in the project final score. The scientific mission is chosen among the missions proposed by the organization for the current year. ,

Precision landing mission: The CanSat has to land on a defined GPS location (usually called "Come back" mission in case of release from a rocket). The GPS data are provided to the team by the organiszation.

Free mission: This mission is proposed by the team.

Missions to be done

[DEF001]

The team will choose a scientific mission and will propose in addition a free mission.

The scientific missions proposed by the organization are described in the “Proposed missions schedule” document and can change from year to year.

[DEF002]

The Come-back mission is proposed as a bonus and is not mandatory. However, this mission is encouraged by the jury.

7. CanSat Specifications

Each CanSat in competition has to fulfill some requirements. The rules are mainly driven by security and operational reasons.

As mentioned in the introduction, the CanSat competition exist in other countries. To be compliant with international rules on one hand but to keep the possibility of testing techniques with few constraints on the other hand, two competition categories have been created in France. The requirements for the International Class are compatible with other CanSat competition guides and allows team to compete in other countries than France. The requirements for the Open class are less strict, in particular to open the competition to secondary school teams.

Volume

[CDC001]

- International Class : the volume of the CanSat should not exceed 33 cL.
- Open Class: the volume of the CanSat should not exceed 1 L.

Masse

[CDC002]

- International Class : the mass of the CanSat should not exceed 350 g.
- Open Class : the mass of the CanSat should not exceed 1 kg.

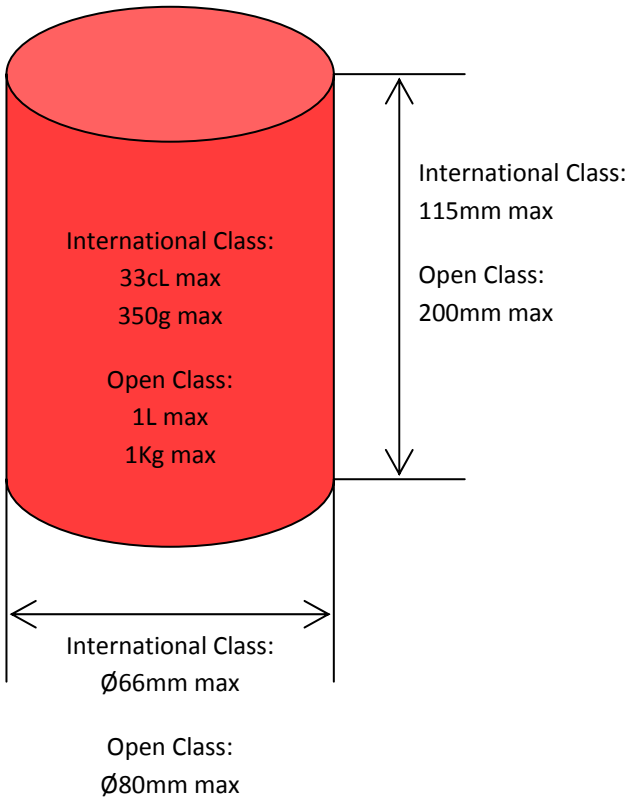
Dimensions

[CDC003]

- International Class : the CanSat should be included in the cylinder of 66 mm diameter and 115 mm height.
- Open Class : the CanSat should be included in the cylinder of 80 mm diameter and 200 mm height.

The CanSat dimensions are checked during the competition thanks to a template in which the CanSat should fit to obtain the authorization for flight.

Synthesis of mechanical constraints



Propulsion

[CDC004]

The CanSat should not use electric, thermal or pyrotechnic propulsion during the flight.

Passive propellers (to reduce the descent velocity when approaching the ground) are authorized.

Activating propellers are expecially prohibited. The rule doesn´t apply to on board actuators like valves, arms, deployment systems.

Appendices

[CDC005]

Any appendices, deployable or not, should be included in the maximal specified volume before release.

An exception is tolerated for the parachute.

[CDC006]

The parachute doesn´t need to be included in the maximal specified volume and mass. An additional mass of 50g and an additional volume is offered for the parachute. The extra allocated volume is the available place in the interface system provided by the organization. Any electrical link between the CanSat and its parachute is prohibited.

Reference position of the target

[CDC007]

The GPS coordinates of the target will be provided to the team by the organization 2 hours before the flight demonstration. Data will be given as in NMEA GGA format; the geodic reference is the WGS84 model

Release altitude

[CDC008]

The release altitude will be between 100m and 150m. The exact value is constant during the release and determined depending on weather conditions.

Initial velocity from the release system

[CDC009]

The CanSat release velocity is close to zero.

Acceleration

[CDC010]

During the ascent phase of the balloon, the vertical acceleration of the CanSat is less than 2g, including 1g gravity. The eventual lateral accelerations are due to wind only.

Distance to the target

[CDC011]

When the CanSat is released, the lateral distance between the CanSat and the target is inferior to the altitude ($\Delta x < \Delta z$).

This lateral distance is approximatively equal to half of the release system altitude ($\Delta x \approx H/2$). Moreover, the target on ground is centered on a circle of radius H/2.

Nota: *Depending on weather conditions, the CanSat release point can be moved by the organization (by moving the attachment on the ground) but with respect to the perimeter defined above.*

CanSat carrier

[CDC012]

The carrier to transport the CanSat up its release altitude is a tethered balloon, provided by the organization.

Wind conditions

[CDC013]

The CanSat release will be authorized only if the wind velocity is less than 5 m/s.

If wind velocity becomes too high or weather conditions don´t allow flight demonstration, operations are stoped for a moment. If unfavorable weather conditions last and prevent the CanSat from being operated, the competition grading will be based on the deliverable documents only and the jury will ask for a ground demonstration.

Interface between the balloon and the CanSat

[CDC014]

The release system is based on gravity. The CanSat is placed inside a tube. The trap door (lower floor) is opened by a telemetry command from the ground operator. When the traps opens, the CanSat is automatically released.

A ring is available if the team wishes to attach a separation detector.

Balloon/CanSat Separation

[CDC015]

The release of the CanSat is controlled by the organization via a telemetry command from the ground.

CanSat/Ground RF link

[CDC016]

Any RF link between the team station and the CanSat is authorized within the rules specified in Appendix 1. There should be no human intervention on the eventually up links commands during the CanSat missions.

[CDC017]

The team should have its own RF telemetry system for emission/reception, modulation/demodulation and coding/decoding. Moreover, the team should provide documents justifying legacy of their emissions (*cf. Appendix 1*).

The relevant frequencies, channel bandwidths and associated powers should be included in the preliminary design report.

This rule is necessary for the organization to plan frequency occupancy during the competition and to check the project conformity regarding the French regulation.

Given the low distance between the CanSat and its ground station, the organization recommends the use of free frequency bands below the legal power (*cf. Appendix 1*).

Planète Sciences can provide the teams with a standard RF emitter (Kiwi Millenium) developed by CNES and used for strastospheric balloons and rocketry. The associated reception stations are also available. Planète Sciences can also provide FSK modulation in the 400-1200 baud range and decoding for SNR protocol. The request of these telemetry means has to be done by the team in the preliminary design report (T1 milestone).

[CDC018]

The CanSat will be equipped with a manual switch to turn off the emitted RF power at any time, to facilitate tests before flight operations and to free frequency bands as soon as the CanSat is recovered.

Reutilization

[CDC019]

The CanSat should be built such a way that a new flight could take place one hour after the previous one.

Only the International class projects are subjected to this rule to be compliant with other international competitions. No constraint of re-utilization is expressed for Open class projects.

Security

[CDC020]

The CanSat should not present any danger for people who work on it.

No pyrotechnics, no dangerous product, no biologic experiment is authorized.

The CanSat mechanical structure should not have any dangerous cutting edge or sharp element.

All these criteria will be tested during the check point to get the authorization for flight

[CDC021]

The requirements regarding the descent velocity are the followings:

- The descent velocity shall not be inferior to 2 m/s;
- The descent velocity shall not be superior to 15 m/s.

In order to demonstrate that its CanSat fulfills the requirement, the team will present its calculation method during the project presentation to the jury (T3 milestone). The team can refer to the Planète Sciences documentation in French concerning the parachutes to estimate the descent velocity as a function of the parachute geometry: http://www.planete-sciences.org/espace/publications/techniques/parachutes.pdf

Expenses

[CDC022]

No requirement is expressed for the expenses of the project.

The budget allocation for equipments and realization has to be presented, including the sponsors contribution if any.

This information is used by the jury to better appreciate the technical quality of the projects with respect to the means on disposal and efforts set up by the teams to finance their project.

8. Operation on the launch area

Written procedures

[OP001]

The team shall prepare a procedure describing each operation done on the CanSat from the arrival on the launch site to the recovery of the project. This procedure will be validated by the organization during the check point (T3 milestone).

This procedure includes operations on the CanSat itself and on the release system too. To help the team to write this document, a guide is available on-line during the current year, at least one month before the T2 milestone.

The procedure will be presented during the check point of the competition. However, it is recommended to deliver it with the final design report (T2 milestone) to get feedback from the technical committee.

Preparation

[OP002]

The team shall be on the launch area 30 minutes before its flight time slot.

The organization provides the teams with tables and, as far as possible, electrical supply. However, it is recommended to be energy autonomous.

Flight planning

[OP003]

Flight time slots are allocated to teams one after the others. The balloon will be available for CanSat integration into the interface tube 15 minutes before the flight.

[OP004]

The CanSat shall be ready for flight at least 20 minutes before the flight.

[OP005]

The access to the safety area will be then limited to safety and control people only.

Delays and unexpected events

[OP006]
The CanSat shall have a minimum 45-minute autonomous electrical supply, flight not included.

If, for reasons beyond the team´s control (weather, organization, technical operations), there is more than 45 minute delay, the team will have the possibilty to change the batteries of its CanSat. If the team is responsible for the delay, its flight time slot may be lost and penality points are included in the project final score.

9. Competition Logistics

Transport / accommodation / catering: Accomodation and transportation from the accommodation area to the launch area can be provided by the organization, as well as full-board catering. Contributions will be asked by the organization.

Tables and electrical supply will be available in the integration hall the day before the flight.

During flight demonstrations, a tent will be available for the teams close to the launch area. There will be tables, where the teams could install their reception stations and other needed equipments. The operation tent is placed such that the flights of the CanSats can be easily seen.

More logistics details could be delivered during the year. It is important to note that the organization will appeal to participants to help for the smooth progress of operations.

10. Available information on the launch area

A small weather station will be available on the launch area in order to provide to participants information concerning:

- temperature
- relative humidity
- atmospheric pression (hPa)
- Wind direction and velocity (m/s)
- Trend for atmospheric pressure evolution

Nota: *Data are measured on ground.*

11. Safety rules of the launch area

Safety rules on the launch site will be detailed during the competition.

In case of breach of a rule, the organization can exclude the concerning team.

The release from a tethered balloon requires safety rules for the public that attend to the flights. The rules are describes in a specific document and results in defining:

- A area for balloon operation,
- A area in tent to welcome the teams,
- A safety manager in the public area.

The team should consider these points in the CanSat operating.

12. Disqualification

The organization will be free to exclude any team or participant in case of violation of the present rules, especially regarding safety aspects.

13. Prizes

The prize-giving takes place after due deliberation of the jury. Prizes are given to the first, the second and the third teams. Each team in competition gets a participation certificate.

14. Link with the organization

All updates concerning time schedule and place of the competition will be announced on the Internet website of the CanSat France competition : http://www.planete-sciences.org/espace/cansat

The deliverable documents shall be transmitted by the teams to cansat@planete-sciences.org.

For other exchanges of any kind (logistics, technical questions…), the teams will exclusively use the forum dedicated to the competition on the Planète Sciences website: http://www.planete-sciences.org/forums, also accessible from the CanSat France competition website.

CanSat website and forum have two main goals:

- Diffusion of information concerning the competition; official documents like the present rules can be downloaded; some forms like the registration form can be directly filled on-line.
- Communication between the participants, the organization and the technical commitee, in order to centralize and make public questions and answers.

Appendix 1: Radiofrequency regulation

The teams are allowed to use their own radiofrequency systems assuming French regulation on the frequencies systems is respected (see ANFR website: www.anfr.fr). When the teams purchase RF equipment from France and do not modify any part of them, the national regulation is thus considered as fulfilled.

For downlink (from the CanSat to the ground station) and uplink transmissions (from the ground station to the CanSat), the use of the Industrial Scientific Medical (ISM) frequency spectrum is recommended (see Table 1). In particular, commercial RF designs should be used on those frequencies.

Table 1: Recommended ISM frequencies for downlink transmissions, and associated maximal RF emiting powers and channel bandwidths.

Frequency band	Maximal Power	Maximal Channel Width
433.05 to 434.79 MHz	10 mW a.r.p. (*)	No restriction
868 to 869.2 MHz	25 mW a.r.p. (*)	No restriction
869.3 to 869.4 MHz	10 mW a.r.p. (*)	25 kHz
869.4 to 869.65 MHz	500 mW a.r.p. (*)	25 kHz
869.7 to 870 MHz	5 mW a.r.p. (*)	No restriction
2400 to 2483.5 MHz	10 mW e.i.r.p. (**)	No restriction

(*)Apparent Radiating Power: ARP(dBW) = $10 \cdot \log_{10}$(Pe) + Ge – 2.14, where Pe(W) is the electrical power from the RF emitter output to the antenna output and Ge(dBi) is the maximal isotropic antenna gain.

(**)Equivalent Isotropic Radiating Power: EIRP(dBW) = $10 \cdot \log_{10}$(Pe) + Ge, where Pe(W) is the electrical power from the RF emitter output to the antenna output and Ge(dBi) is the maximal isotropic antenna gain.

The frequencies allocated to the CNES “Kiwi Millenium” RF transmitter can be used, considering the restrictions of Table 2.

Table 2: Regulation for the use of the CNES Kiwi Millenium frequencies

Frequency band	Maximal Power	Maximal Channel Width
137.95 MHz and 138.50 MHz	500 mW e.i.r.p. (***)	50 kHz

(**)Equivalent Isotropic Radiating Power: EIRP(dBW) = $10 \cdot \log_{10}$(Pe) + Ge, where Pe(W) is the electrical power from the RF emitter output to the antenna output and Ge = 2.14 dBi.

Nota : Each team must provide in the preliminary design report its RF design, which must include for each link/ FR frequencies with channel bandwidths and maximal ARP or EIRP. A unique frequency by type of link (downlink or uplink) is allocated for each team.

The organization defines a frequency allocation plan in order to mitigate any frequency interferences. When frequency conflict appears, the organization may ask to the concerned teams to change their emitting settings (frequency band, emitting power or channel witdth).