



INTRODUCTION NOTE TO ESA “FLY YOUR THESIS!” PROGRAM CRITERIA AND LEVEL OF TECHNICAL DETAILS FOR SELECTION PROCESS


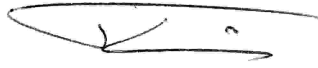
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CONCURRENCE

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CHANGE RECORD

Issue date	Change Resp.	§	Purpose
Sept. 2009	FG	Footpages	Update of copyright sentence
Apr. 2010	FG	3	Update for biomedical experiment involving test subjects

REFERENCE

[REF.1] : NOVSPACE "Rules & Guidelines" - RG

Note: [REF.1] is available at following link:

http://documentation.novospace.com/externe/last_applicable_rq/

ID : exp

Password: doc71_u3

[REF.2] : Experiment Safety Data Package – ESDP

[REF.3] : <http://www.esa.int/SPECIALS/Education/>

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1. INTRODUCTION

Since 2009, ESA Education Office is offering European students the opportunity to perform an experiment in weightlessness during Parabolic Flight Campaign. The “Fly your Thesis!” programme gives Master and PhD students the possibility to fly their scientific experiment in microgravity, by participating in a series of parabolic flights on the Airbus A300 ZERO-G aircraft. Each selected student team has to design an experiment to be performed in microgravity, as part of their thesis or research programme.

This program is replacing the former student parabolic flight programme which stopped in 2006.

The student experiment selection process is divided into several steps (see [REF.3]) in which students should provide reviewers with administrative, scientific and technical information on their experimental test setup. At B.0-1 step, students are requested to fill in the first revision of experiment technical documentation (ESDP – [REF.2]). This document will be used to assess the risks and technical issues related to the experiment.

Most of the time, experiments are operating hardware that could bring some hazards. The design of the experiment will always have to take into account two distinct parameters: scientific goal and level of risks. The experiment should always be as safe as possible while still achieving the desired scientific results. The design with a risk-oriented approach is usually not really taken into account when designing an experiment on ground. This approach is usually overlooked; However, it has a significant importance for parabolic flight experiments:

- Environmental conditions are unusual:
 - Weightlessness could induce hazardous situations, e.g. a glass sample could lead to glass debris in microgravity and then injure operators' eyes.
 - At NOVSPACE, different conditions apply compared to normal laboratories, e.g. biological material with a Biological Safety Level of 2 (BSL-2) or greater can not be handled in our BSL-1 laboratory. In addition, the available space has to be shared in between all the teams.
- On ground, it is most of the time possible to run away in case of fire. Within an aircraft in flight, it is absolutely not possible. Even a small fire could lead to catastrophic situation if not attended quickly.
- The A300 ZERO-G is obviously not equipped with all medical equipment for facing every medical emergency situation. Bringing an injured person to hospital will probably request more time than what is usually feasible while on ground.

In the frame-work of this student program, the experiments are proposed by students. Due to the following reasons the equipment and activities will be more restricted than in the case of non-student scientists:

- Parabolic flights are short term processes,
- Students are not 100% available for their experiment (University courses, training periods, ...),
- Students will most probably design and manage for the first time a project with a lot of requirements,
- Students will have to ensure an appropriate coordination with several entities (ESA, NOV, ELGRA mentors, university workshop),

The purpose of this document is to provide students with:

- Information regarding technical & safety selection criteria
- Level of information requested for filling the first revision of the ESDP at selection step.
- General advice and tips for managing the project.

2. TECHNICAL & SAFETY SELECTION CRITERIA

In order to be selected, applicants should comply with administrative, scientific, technical and safety criteria. While the first two are defined by ESA, technical & safety criteria are presented hereafter.

At application level, applicants should think at the application level that one experiment will always bring some hazards. The experimenters must be aware that their experiments will be performed in several new environments, e.g. within the parabolic flight campaign ground facility and the A300 ZERO-G. These new environments should be taken into account from the beginning of the experiment design activities in order to assess and minimize all risks. There are many differences between the A300 ZERO-G environment and a usual lab environment. A remarkable fact is the change of load factors. 0g or 1.8g can generate a hazard on an experiment which would have been safe in a 1g environment (e.g. in case of leakage at 0g, products float and can be inhaled, or reach the passengers' eyes). Another remarkable fact is that the experiment is performed in an aircraft:

- When the aircraft is flying, the experimenters cannot escape from a hazard,
- A hazard becomes automatically catastrophic as soon as it is threatening the aircraft integrity.

NOVSPACE premises have also to be considered as the whole preparation of the experiment is performed in a new laboratory shared with other experimenters.

Last but not least, possible human failures have to be all the more taken into consideration since the aircraft and microgravity environment is so unfamiliar. In addition, the human being is known to be the main source of errors within a system, most of all when this system is innovative.

In the whole process of preparing for the Parabolic Flight Campaign, the experimenters should take into account:

- All intrinsic hazards from the experiment itself,
- The test setup behavior under new g-level changes,
- The closed environment of the aircraft (vibrations, noise, stress ...),
- The human mishap due to the change of ground facility,
- The human mishap due to weightlessness or hyper gravity environment.

As explained earlier in the introduction, for student experiments NOVSPACE prohibits some hazardous equipment or activities that could otherwise possibly be accepted (provided prevention and protection means are adequate) for regular scientific experiments.

The following list shows common hazards and some technical limitations. The reviewer of student experiment will at minimum base his safety assessment on this list. Obviously, the list is not exhaustive and could then be upgraded while reviewing the student technical application. Some of the criteria are quantitative and some are qualitative. When qualitative criteria are shown, the reviewer of the proposal is free to assess if the experiment should be considered as safe or not.

The purpose of this list is to provide the student with design and operational limits.

The compliance with items in the following list does not mean that the experiment will be selected or even assessed as safe.

Equally, the non compliance with some items should not be considered as critical if the experiment description shows the risk is managed with appropriate safety means and appropriate training on the equipment or activity generating the risk.

Even after the selection of an experiment, the non compliance with this minimal list of criteria or with [REF.1] could lead to the decision not to fly an experiment as it has already happened in the past.

The following limits or state should be considered as prohibited:

Biological & Chemical	
Biological Safety Level > 1	Proposal will not be accepted if biological material have BSL >1. Novespace laboratories are limited to BSL-1 biologic agent handling.
Very Toxic (T+) product.	Toxic products will not be accepted unless the concentration in solution is shown as safe. Full demonstration to be provided.
Experiment using radioactive materials or that generate ionizing radiation.	Not accepted. if requiring accreditation according to the French law.
Extremely flammable (F+) / explosive (E) products	Not accepted. This includes gas and liquid vapor.
Genetically Modified Organism (GMO)	Not accepted. According to French regulation, the handling of such material requires a specific agreement.
Note on GMO: GMO definition according to French regulation is provided in §4.5.2 of NOVSPACE "Rules & Guidelines" [REF.1]	
Important note: toxic (T), irritant (Xi), harmful (Xn) or flammable (F) material should be in very low quantity.	

Pressure	
Circuit with Pressure x Volume product > 4 litres-bars	Only low pressure systems could be accepted.

Temperature	
Liquid temperature >+49°C, for a liquid quantity > ½ L..	Defined limits should be respected.
Liquid temperature >+60°C, for a liquid quantity < ½ L.	
Any material having a temperature exceeding +60 °C.	
Contact temperature of the experiment hardware and products under 0 °C.	

The following limits or state should be considered as prohibited:

Liquids	
Liquid quantity > ½ L.	Whole liquid quantity within an experiment should remain within half litre, unless strictly necessary.
Liquid not double contained.	<p>The sealing of liquid container(s) will have to be proven before the flights.</p> <p>A singled sealed container is tolerated only for pure water within the limit of ½ L quantity.</p>

Electrical/Radiation	
Extreme magnetic field.	Value should remain as low as possible.
High Power	
All electrical equipment powered with voltage above 32V: <ul style="list-style-type: none"> • Without CE marking or equivalent accepted national standards or • With CE marking but modified 	Not accepted
Laser with a class above class 3B, according to IEC 60825-1 classification	
Not contained laser beam	
Electrical circuit not build by professional.	Not accepted. Electrical circuit is including all connectors (incl.experiment power plug), all equipment connexion, safety electrical equipment (fuse, GFI, ...) and wiring.

Mechanical	
High energy system e.g. springs, high vibration level, flywheels, ...	Such value should be as low as possible. This is typically a qualitative criterion. The system or the equipment hazard will be assessed according to the provided information and with the knowledge from the reviewer.
Experiment with overall mass above 75kg	The experiment mass should be limited as low as possible and within this limit.
Experiment size: floor area should be less than 2x2 m ²	This parameter is taken into account by the reviewer for the selection. It is better to keep things as small as possible.
Experiment assembly not built by professional mechanics	Not accepted
Experiment not protected by sharp edges, or generating risk of pinches or injury	Not accepted

The following limits or state should be considered as prohibited:

Module deployment in free-floating	
Free-Floating module with mass > 10kg.	Exceeding this limit will lead to reject the experiment.
Free-floating module risking loss of control.	Any module in free floating should have minimum restrains to limit uncontrolled movement.
Experiment requiring deployment surface of more than 1.5x1.5m	Limitation of the available space due to space sharing with other experiments

Life Science experiment	
Biomedical experiment with human test subject (even for experiment on oneself and/or with no invasive measurement)	Accepted but limited to criteria listed below
<ul style="list-style-type: none"> • Proposed experiment should be closely linked to the student's thesis, • Measures to be performed on test subject should be in relationship with thesis' purpose, • The students should be qualified for the proposed medical procedures, • Proposed experiment should have received during the parabolic flight process a positive assessment either from ESA medical Board or from relevant scientific committee. The assessment should have obtained at last 2 months before the flights, • Proposed experiment should have received and approval from local ethical committee before the flights • Upon the complexity or the technicality of the experiment, ESA/NOVSPACE could request the presence of the endorsing professor • Invasive measurements are not accepted. 	
<p>Note: according to French regulation, a biomedical research is a research organized on human being with the objective of increasing medical or biological knowledge. Even non-invasive, simple experiments are considered as biomedical research. For instance filming a team member movement in zero-g, or showing a person pictures and asking him to tell what he has seen, or having a person smelling current odours to check if the perception is different in zero-g, are considered as biomedical researches and will only be selected in the Fly your Thesis parabolic flight upon above mentioned criteria.</p>	
Biological experiment on vertebrates.	Authorization for working with such animal under assessment.
<p>Note: list of animals with restriction could shortly evolved to become more restrictive</p>	

3. SELECTION PROCESS – ESDP SECTION TO BE FILLED-IN

The preparation of an experiment for Parabolic Flights requires to complete several technical documents. At the beginning of the process, ESA and NOVSPACE will ask students to fill in the EXPERIMENT SAFETY DATA PACKAGE (ESDP) [REF.1] used for the technical description and hazard analysis of the experiment in-flight and on ground; this includes procedures, equipment and all materials (solids, liquids and gas) used in-flight and on ground. Based on this document, NOVSPACE engineers will analyze and support the experiment design. The ESDP [REF.1] will be the document supporting the technical communication between students and NOVSPACE. NOVSPACE engineers will use this document in order to review experiments and accept test set-up in NOVSPACE premises.

In addition, ESDP will also be reviewed by an independent panel composed of experts from the CEV (French Flight Test Center) which is in charge of flight operations and safety on board the A300 ZERO-G.

On a case by case basis, the ESDP can be reviewed by safety and/or scientific experts from either the inviting Space Agency, or an external organization.

At selection process, it is not necessary to completely fill-in the ESDP. The table below gives an indication of the mandatory and optional sections. It absolutely important to note that all ESDP section will have to be filled in once the experiment is selected.

ESDP §	Comments
§1	<p><u>Mandatory.</u></p> <p>The Principal Investigator should be the endorsing professor.</p> <p>The technical contact should be one student</p>
§2	<p><u>Optional</u> until the end of selection process. It will become mandatory after experiment selection.</p> <p>List of changes to the Experiment Form</p> <p>This part will be used to show the differences between different ESDP revisions send to NOVSPACE. For the first issue of the document, at selection level, you just need to give the issue date and mention that all chapters are concerned.</p> <p>Changes made to the experiment since last campaign</p> <p>You just have to mention that “The experiment is participating for the first time to a Parabolic Flight Campaign”. Table could be removed.</p>
§3	<p><u>Mandatory.</u></p> <p>An abstract on scientific goal and the relevance of microgravity should be given here.</p>
§4	<p><u>Mandatory.</u></p> <p>Give an overview of the experiment showing how to reach scientific goal described in §3. This part should provide the reader with general idea about systems and physical phenomena to be implemented.</p>

§5	<p><u>Mandatory</u> - System description</p> <p>Each system of the foreseen experiment should be described (e.g. pressure system, acquisition/diagnostic system, control circuit, ...) one by one. At selection level, it does not need to be detailed, but details will be appreciated.</p> <p>This section have to be filled in with a convenient level of details, presenting systems and their subsystems.</p> <p>Example: a rack will include a rotating system. The rotating system must be explained presenting the motor, its speed range, its control chain with sensors, the related safety devices (fuse, software loop, etc..), its links with the others elements, and so on.</p> <p>The best way to explain things consists in mixing written information (use paragraphs or tables), block diagrams and drawings.</p> <p><u>Optional</u> - Components description</p> <p>List of components could be given even if not exhaustive.</p> <p><u>Optional</u> - Rack schematic</p> <p>A rack overview will be appreciated</p> <p><u>Optional</u> - List of auxiliary equipment</p> <p>Not necessary at selection step.</p> <p>Optional sections will become mandatory after experiment selection.</p>
§6	<p><u>Mandatory</u> - Products used in Flight</p> <p>Name and quantity of all liquid and gas should be provided.</p> <p>Others information are optional until the end of selection process.</p>
§7	<p><u>Optional</u> until the end of selection process. It will become mandatory after experiment selection.</p>
§8	<p><u>Mandatory</u> - Total Power Consumption and Fast Fuse</p> <p>Only "Estimated Total Power Consumption" is requested. Other data from the table are optional.</p> <p><u>Optional</u> - other part of the section</p> <p>Optional until the end of selection process.</p> <p>Optional sections will become mandatory after experiment selection.</p>
§9	<p><u>Mandatory</u></p> <p>First three columns of the first table to be filled in.</p> <p>Others information are <u>optional</u> until the end of selection process.</p>
§10	<p><u>Optional</u> until the end of selection process. It will become mandatory after experiment selection.</p>
§11	<p><u>Mandatory</u> - Procedure on the day of the flight</p> <p>Requested</p> <p><u>Optional</u> - other part of the section</p> <p>Optional until the end of selection process.</p> <p>Optional sections will become mandatory after experiment selection.</p>

§12	<p>This part is not mandatory but the team should soon start to think about how this part needs to be filled in. Due to the importance of such a topic, NOVSPACE do not ask experimenters to fill in this part at selection step, but it should be kept in mind the risk management begins at project start-up.</p> <p>Rules & Guidelines [REF.1] should be carefully reviewed by the team to address this part. It would be really appreciated if the team could at least prepare a list of hazards present on their experiment. It could be either done with a simple list or by filling in the header of hazard reports. Anyway, risk analysis will have to be performed during the experiment preparation once the experiment is selected.</p>
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HAZARD REPORT #1	
Writer name:	<i>Xxx</i>
Hazard Classification:	Catastrophic / Critical / Major
Hazard Description:	<i>Description of the Hazard</i>

Please note that to start this work it is mandatory to start by reading the Rules and Guidelines document (RG) [REF.1], §2. A good support in hazard identification is in Appendix A of the RG.

§13	<u>Optional</u> until the end of selection process. It will become mandatory after experiment selection.
§14	<u>Optional</u> until the end of selection process. It will become mandatory after experiment selection.
§15	<u>Optional</u> until the end of selection process. It will become mandatory after experiment selection.
Appendices	<u>Optional</u> until the end of selection process. It will become mandatory after experiment selection.