



Required Specificity for Description of Experiment Samples SSEP Missions to the International Space Station

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The purpose of this document is to provide guidance to student teams for how to specify their experiment samples (fluids and solids) in order to meet requirements for formal NASA flight safety review. While the level of specificity detailed in this document is not absolutely required in the proposals – meeting the requirements stated in the Proposal Guide is sufficient for submitting a proposal – it is highly advisable for all teams to adopt this level of specificity even in their proposals. If a team's proposed experiment is tentatively selected for flight, they will need to have full specificity of samples for their experiment to be formally selected as the flight experiment, and be submitted for flight safety review.

I. Detailed Description of Experiment Samples

All experiment samples must be listed in as much detail as possible. For example:

- For plants and animals, it is advisable to include the scientific name; *e.g.*, Radish seeds (*Raphanus sativus*);
- For liquids, the description must include as much information as available; *e.g.*, distilled water; tap water from Fargo, ND; tap water from Fargo, ND, dechlorinated with AquaSafe.

The more information you can provide about your samples, the better. This specificity extends to listing the exact amounts of each sample. For example:

- For fluids, you can list:
 - the volume; *e.g.*, 0.1 ml of distilled water;
- For solids, you can list:
 - the volume; *e.g.*, 0.1 ml *Bacillus subtilis* spores;
 - the mass; *e.g.*, 0.1 g Baker's yeast (*Saccharomyces cerevisiae*);
 - the dimensions; *e.g.*, 0.5 x 0.5 cm piece of cotton;
 - the number to be used; *e.g.*, 3 radish seeds (*Raphanus sativus*).

There is only one exception to the requirement of listing the precise amount of a sample: If you want to have an experiment volume filled completely, you can say, for example:

- FME Volume (Type 1 FME):
 - Distilled water: The volume is filled to capacity, approx. 10.00 ml

In this case, stating, "approx. 10.00 ml" is acceptable, since the reviewers will know that the experiment volume is filled completely, even if there were to be minute changes in the volume (to, say, 9.85 ml) during the loading of the samples into the experiment device. The key statement in this case is "filled to capacity." As an additional note, when listing the amounts of

the samples, keep in mind the maximum volumes of each experiment volume; see the mini-laboratory operation page for your Mission on the SSEP website for details on the experiment volumes of the different types of FMEs.

II. Concentrations

The samples list submitted to the NASA flight safety review must include the *concentration* for each sample. For example, if you want to use sodium chloride (NaCl) in distilled water, you must explain how much NaCl you plan to mix with the water. Below are a few examples of different ways you can provide the concentration:

- 5 mg/ml sodium chloride (NaCl) in 1.5 ml distilled water
- 0.06 ml of sodium chloride (NaCl) in 1.23 ml distilled water
- 5% sodium chloride (NaCl) in distilled water: volume is filled to capacity, approx. 1.85 ml

If an experiment volume contains multiple fluids, you must include precise measurements for both fluids; for example:

- Volume 1 (Type 2 FME):
 - 1.0 ml distilled water
 - 0.85 ml canola oil

If you are using a solid sample in an experiment volume, you must include:

- the dimensions; *e.g.*, 0.5 x 0.5 cm piece of cotton in distilled water: Volume filled to capacity, approx. 1.85 ml; or
- the number to be used; *e.g.*, 60 polystyrene particles (microspheres 500µm in diameter) suspended in distilled water: Volume filled to capacity, approx. 1.85 ml.

If you are using a microbiological sample, such as bacteria, you must include the concentration in an appropriate way, such as the number of organisms in a given volume. For example, you can specify the number of Colony-Forming Units (CFU), such as:

- *E. coli*, freeze-dried (1.4x10⁸ CFU/ml): Volume filled to capacity, approx. 0.92 ml

III. Restrictions on Samples

The following are restrictions and requirements regarding the fluids and solids that can be used in the FME mini-lab:

a. *Prohibited Samples*: Student teams must **NOT** use any of the following fluids and solids: radioactive fluids or solids, perfumes, hydrofluoric acid, magnets, cadmium, beryllium, and acetone.

A finalist proposal submitted to NCESSSE that contains any of the substances listed above will be rejected automatically and will not move forward to the Step 2 Review Board for review.

b. *Hazardous Samples*: NanoRacks and NASA reserve the right to refuse other fluids/solids not included in the list above based on hazard level. All student teams proposing experiments are therefore advised to consider carefully the level of hazard posed by the samples they are

planning to use, even if they are not included in the list of prohibited samples above. If your experiment is making use of something that is known to be hazardous, NCESSSE advises you to alert us as soon as the potential hazard is identified as part of your experiment brainstorming so that we can have NanoRacks assess the hazard and any potential impact on NASA Flight Safety Review.

Examples of hazardous samples that require NCESSSE to be contacted as soon as such a sample is being considered by a student team:

- fluids/solids that are hazardous enough that there is concern that the student teams are handling these substances
- fluids/solids that when mixed can result in excess heat and/or pressure inside the tube, leading to loss of containment (such fluids/solids can also be denied if there is evidence that excess heat – even chemically generated light – can adversely impact other FMEs that share the payload box on ISS)
- biologicals with a designated BioSafety Level (BSL) of 2 or higher (see this CDC slideshow for more information)

c. Problematic Samples: there are a significant number of fluid/solid samples that can adversely interact with the mini-lab's silicone tube. These samples cannot be used in a 100% concentration; however, these materials may be used on a case-by case-basis depending on proposed concentrations, volumes, solutions, etc. NanoRacks therefore asks all student researchers to assess if any of their proposed fluids and solids are on the NanoRacks **List of Problematic Samples** document and if so, contact NCESSSE as soon as such a substance is being considered for an experiment so that NanoRacks can review and rule on whether it can be used. The List of Problematic Samples document is located in the Document Library.

d. Technology: teams may not propose to fly technology in the FME. This includes batteries, lighting, and any device that is associated with electrical circuits and/or mechanical systems. Such technology is not covered by flight safety review. It requires a more detailed and lengthy process of flight certification. SSEP does not support flight certification of technology for placement inside the FME.

IV. Examples

Below are a few examples of descriptions of experiment samples from previous SSEP flight opportunities that have passed NASA flight safety review. Some of the examples are from experiments using a different experiment apparatus with different experiment volumes, but they provide a good idea of the level of specificity required for the flight safety review. These examples include:

- Cotton: 0.3 cm x 0.3 cm
- Yeast (*Saccharomyces cerevisiae*): 2 ml
- Madeira wine: The well is filled to capacity, approx. 1.25 ml
- 5 *Arabidopsis thaliana* wild-type seeds
- 3 tomato seeds (*Lycopersicon Lycopersicum* (L.) Karsten e.g. Farw., var. Marglobe)

- Brine shrimp eggs (cysts): 5 microliters
- Tardigrades: live *Milnesium tardigradium* culture supplied by Carolina Biological Supply (125 microliters of artesian spring water containing algae and tardigrades: 10-30 tardigrades of the above named species): The well is filled to capacity, approx. 125 microliters
- Algae: *Chlamydomonas reinhardtii* (1mg / ml of LB media) in Luria broth (LB) media: The volume is filled to capacity, approx. 5 ml
- Distilled water: The well is filled to capacity, approx. 8 ml
- Distilled water with 5% NaCl (0.05 ml/1 ml): The well is filled to capacity, approx. 125 microliters
- Water: tap water from the city of Chicago municipal water system, dechlorinated with AquaSafe: The well is filled to capacity, approx. 5 ml
- Luria broth: The well is filled to capacity, approx. 5 ml
- Aqueous solution of 10% polyvinylpyrrolidone (Distilled water with 10% polyvinylpyrrolidone): The well is filled to capacity, approx. 125 microliters.
- DMEM cell culture medium (w/ 4.5 g/L glucose) with 10% fetal bovine serum and HEPES: The well is filled to capacity, approx. 125 microliters
- OASIS (substrate material used by florists): 1.6 cm (height) x 0.318 cm (diameter)
- 2.5 ml of 10% solution of neutral buffered formalin (NBF)
- 0.5 ml *Ralstonia eutropha* in phosphate-buffered saline solution
- Nutrient Agar/ broth (6 ml)
- Freeze-dried *Bacillus subtilis* one ampoule (approximately 5 mg)
- Diphenylamine; *Bacillus subtilis* inhibitor (2 ml)
- 2 ounces, white bread
- 6 ml, Formalin (NBF): 10% Neutral Buffered; approx. 3.7% formaldehyde in phosphate buffered saline
- Lettuce (*Lactuca Sativa*) seeds - 30 seeds
- Rockland County Tap Water, 3 milliliters
- 99% Isopropyl Alcohol in water, 3 milliliters
- 4g Calcium Sulfate powder (Hemi-Hydrate) from Sigma-Aldrich item #12090-1KG-R
- 4 mL distilled water

V. Additional Information Required for NASA Flight Safety Review

NASA flight safety review requires that the teams list the pH of their fluid samples. While providing this information is not required in the proposal, given that these details must be made available before the selection of the experiment for flight can be confirmed, the proposers may want to include the pH of their samples in their proposal, or at least have them readily available during the proposal review.

When the experiment details are submitted to the flight safety review, there are additional documents that the experiment team must provide for their samples. The proposers are advised to read through the mini-laboratory operation page for your Mission on the SSEP website for more information on the Material Safety Data Sheets (MSDS) and the proof of required testing of any human samples to be used in the experiment. While these documents do not need to be submitted with the proposal, the tentatively selected flight experiment teams must be able to provide them before their selection can be confirmed. Therefore, it is advisable for the teams to start thinking

about these documents even before the selection of flight experiments. This is especially important if the team is planning on using human samples, since if the team cannot secure the required certification of testing from the sample vendor, they must arrange to have these tests performed in a medical laboratory on their own, and many of these tests can take quite a while to perform.