



Canadian Reduced Gravity Experiment 2019: Project Maple

CAN-RGX Experiment Assembly and Operations Procedures

Compiled on 2019-07-22

Background and Reference

Contents

This document contains the following:

- **N1** *Experiment Assembly* comprised of all steps that can be completed before the day of flight.
- **N2** *Pre-Flight Setup* comprised of all steps to be completed immediately before boarding the Falcon.
- **N3** *In-Flight Operations* comprised of setup, experiment procedures, and contingency plans to be executed aboard the Falcon.

Personnel Required

There are 4 people required for us performing at CAN-RGX.

- 1 ☐ **Riley [Payload Commander]** is responsible for organizing and overseeing operations and crew, as well as liaising with SEDS and NRC staff. Primary operator for setup and experiment procedures.
- 2 ☐ **Kyle [Payload Specialist]** is responsible for assisting the **Payload Commander** with experiment setup and operation. Both the **Payload Specialist** and the **Payload Commander** will be flying in reduced gravity aboard the Falcon.
- 3 ☐ **Mission Specialist 1** and **Mission Specialist 2** are responsible for assisting the flight operators with ground based setup and debugging on the tarmac before **Payload Commander** and **Payload Specialist** board the Falcon.

Sign-Off

To be completed by all CAN-RGX personnel after reading and familiarization with procedures

- | | | | |
|---|---------------------------------------------------------------|-------|-------|
| 1 | <input type="checkbox"/> Riley [Payload Commander] | _____ | _____ |
| 2 | <input type="checkbox"/> Kyle [Payload Specialist] | _____ | _____ |
| 3 | <input type="checkbox"/> Teresa [Mission Specialist 1] | _____ | _____ |
| 4 | <input type="checkbox"/> Aaron [Mission Specialist 2] | _____ | _____ |

[N1] Experiment Assembly

- 1 ☐ Ensure Velcro straps over cell boxes make a secure connection and are not prone to accidental removal.
- 2 ☐ Lay out a sheet of shop towel, and place all test cells vertically on top of this sheet.
- 3 ☐ One at a time, fill the test cells with coloured water using a syringe and pipette. Filled cells will be searched for immediate leaks.
- 4 ☐ If a cell leaks immediately, it should be quickly drained, marked as leaky and set aside. This cell will be excluded from the experiment.
- 5 ☐ Cells that do not show any immediate signs of leaks will be plugged:
 - 6 ☐ Using Q-tip, apply a thin coating of Vaseline to a shortened rubber stopper.
 - 7 ☐ The lubricated stopper will be pushed and subsequently twisted into the fill port of the cell in question.
 - 8 ☐ A light bead of hot glue will be applied around the base of the stopper.
- 9 ☐ Plugged cells will be placed face down on the shop towel and left for at least 30 minutes, longer if schedule allows. Procedure shall continue while cells are sitting.
- 10 ☐ Using 3/16" and 4mm Allen keys for 1/4-20 and M5 screws (respectively), check tightness of all fasteners.
- 11 ☐ Check connection of lights on lid, ensure they aren't prone to falling off.
- 12 ☐ Connect camera remote to cell phone, and plug phone charger into Pelican Case.
- 13 ☐ Secure camera into phone holder, and plug into charger.
 - 14 ☐ Ensure phone is charging properly.
 - 15 ☐ Use remote to start video on the camera.
 - 16 ☐ Close case lid and use light remote to turn on interior lights to 80% brightness.
 - 17 ☐ Wait several seconds, then turn off camera and lights and open the Pelican Case.
- 18 ☐ Open storage information of phone camera.
 - 19 ☐ If >10 GB is available, phone setup is complete.
 - 20 ☐ If 10 GB of storage is not free, go to files, photos and videos and delete enough to ensure >10 GB of storage is free.
- 21 ☐ Repeat step 9 with backup camera.
- 22 ☐ Once all setup is complete and half-hour has been waited, check fluid cells again for leaks apparent on the shop towel.
 - 23 ☐ Any cells with leaks shall be drained, and set aside for exclusion from the experiment.
 - 24 ☐ Cells that are not leaking shall be drained, and replaced in their holding boxes. Draining will be performed as follows:
 - 25 ☐ The ring of glue will be pulled off using a dental pick.
 - 26 ☐ Rubber stopper will be carefully removed using side-to-side motion.
 - 27 ☐ Vaseline will be cleaned off of rubber stopper with shop towel.
 - 28 ☐ Cell will be inverted over a waste container and gently patted until all fluid is drained.
- 29 ☐ Ensure test cells fit well in cell sites, and the Velcro adhering them holds firm.

End of Experiment Assembly

[N2] Pre-Flight Setup

- 1 ☐ One at a time, the remaining valid test cells are to be filled with their designated amounts of ferrofluid using a syringe and pipette.
- 2 ☐ Each geometry of cell will have the first cell filled to 1/3 fill height, the second to 1/2 fill height.
- 3 ☐ Filling will consist of the following:
 - 4 ☐ Shoot 3-6 mL of WD-40 in the test cell.
 - 5 ☐ Shake and move cell around to coat walls in WD-40.
 - 6 ☐ Use first syringe, then pipette to carefully transfer ferrofluid from its bottle into the test cell.
- 7 ☐ After each fill, the test cell in question will be plugged:
 - 8 ☐ A shortened rubber stopper will be lightly greased with Vaseline, using a Q-tip.
 - 9 ☐ The greased stopper will be pushed and then twisted into the fill port of the cell in question.
 - 10 ☐ A thin bead of hot glue will be applied around the base of the stopper.
- 11 ☐ Each cell will be examined closely for any fluid leaks. Any leaking cells will be emptied and removed from the experiment.
- 12 ☐ Any changes necessary to cell numbering due to excluded test cells will be made now at the discretion of the Mission Specialists.
- 13 ☐ When all cells are filled, they are to be loaded into their holding boxes and secured with the Velcro strap.
- 14 ☐ The camera phone will be secured in its holder and plugged into the pelican case for charging.
- 15 ☐ Connectivity between light, phone and their respective remotes will be ensured before they are turned off and the Pelican Case is closed.
- 16 ☐ Experiment is now ready for integration with the Falcon 20, pending recommendations by NRC staff.

End of Pre-Flight Setup

In-Flight Operations

Level Flight Setup

The following will be performed during every level flight section between parabolas. A detailed list of which cells and magnet positions are to be used for each parabola can be found immediately following this section.

- 1 ☐ If anything is noticed to be broken, loose, or otherwise in need of repair, the parts in question will be fixed at the discretion of the operating technicians.
- 2 ☐ Any unnecessary test cells in test sites will be removed by pulling on their securing Velcro. Remove the new test cells from their holding boxes and attach them to the test sites using the Velcro. The cell boxes will be resecured with their Velcro straps.
- 3 ☐ Required magnets will be removed from their holding cases in the toolbox and placed into the specified test holder locations. Any magnets previously installed that are not necessary will be removed. Needle-nosed pliers (found in toolbox) may be needed to remove magnets.
- 4 ☐ All tools used will be returned to their designated storage place, all loose parts will be secured and the lid of the Pelican Case will be closed.

The following steps need only be performed on the first setup period and will be left on for the remainder of the flight.

- 5 ☐ Once lid is closed, camera will be turned on by remote.
- 6 ☐ Interior lights will be turned on to 80% brightness by remote.

Parabola #	Test cells in use	Magnet Positions
1	1,2,3,4	O
2	1,2,3,4	L
3	1,2,3,4	L, R
4	5,6,7,8	O
5	5,6,7,8	L
6	5,6,7,8	L, R
7	9,10,11,12	O
8	9,10,11,12	L
9	9,10,11,12	L, R
10	1,2,3,4	O

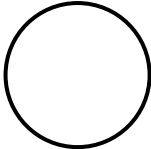
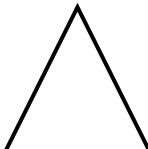
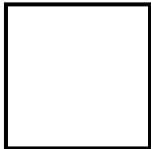
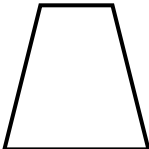
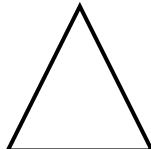
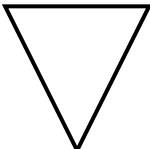
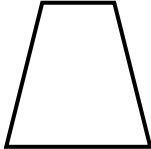
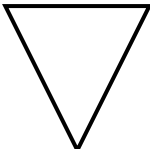
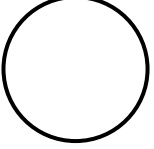
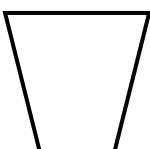
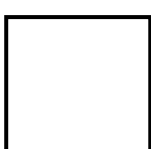
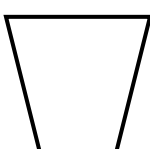
Reduced Gravity and Emergency Operations

The following will be performed for every reduced gravity section of flight. Exact details about the current configuration can be found in the table above.

- 1 ☐ The experiment will be left to run on its own, as it is fully passive. During operation, Mission Specialists are to be watching for anything that goes wrong or needs attention. This section is intended for use in case of mishaps.
- 2 ☐ Ferrofluid Spill/leak:
 - 3 ☐ The leaking cell will be identified, removed from the test site and wrapped in absorbent cloth.
 - 4 ☐ Cell and cloth will be placed in a large Ziploc bag, the bag will be sealed and placed in the flight toolbox.
 - 5 ☐ If fluid has contaminated any parts of the experiment, it will be cleaned up with absorbent cloth and water (if necessary).
 - 6 ☐ Leaking cell will be excluded from operations and the experiment may continue, provided there is no extensive damage to the system.
- 7 ☐ Power Loss:
 - 8 ☐ Experiment will continue without charging to phone camera.
- 9 ☐ Camera Failure:
 - 10 ☐ Should the camera stop recording, or be incapacitated in some other way, it will be promptly removed from the experiment.
 - 11 ☐ The secondary Mission Specialist will have a phone camera on their person that will be substituted for the original.
 - 12 ☐ The experiment can proceed using new hardware.
- 13 ☐ Motion sick/unconscious crew member:
 - 14 ☐ For minor motion sickness, crew will follow given minimization tactics and wait for sickness to pass.
 - 15 ☐ For severe cases and unconsciousness, NRC staff will be alerted and judgement will be deferred to qualified staff.

End of In-Flight Operations

Cells and Magnet Positions

1		1/3 Full	7		1/2 Full
2		1/3 Full	8		1/2 Full
3		1/3 Full	9		1/3 Full
4		1/3 Full	10		1/2 Full
5		1/2 Full	11		1/3 Full
6		1/2 Full	12		1/2 Full

