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FALCON 20
USER'S GUIDE
MAY 2001

Canada

CANADIAN SPACE AGENCY
NRC FALCON 20 Reduced Gravity Aircraft
USER'S GUIDE

FOREWORD

The purpose of this document is to provide a guideline for users of the NRC FALCON 20 reduced gravity aircraft who are participating in a flight campaign organized by the Canadian Space Agency. This guideline presents a description of the FALCON 20 facilities and outlines the requirements for test personnel, equipment design and installation, mission preparation and in-flight procedures.

Any questions regarding this document, scheduling, or the microgravity program in general should be directed to:

Microgravity Sciences Program
Canadian Space Agency
6767, route de l'Aéroport
Saint-Hubert, Quebec J3Y 8Y9

Phone: (450) 926-4782
Fax: (450) 926-4766

Any questions regarding the aircraft or experiment design factors should be directed to:

NRC/Flight Research Laboratory
CFB Uplands Airport, Building U-61
Ottawa, Ontario K1A 0R6

Phone: (613) 998-3230
Fax: (613) 952-1704

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1.0 PROGRAM DESCRIPTION

The Canadian Space Agency provides access to a reduced gravity environment for Canadian experimenters using NRC's FALCON 20 aircraft on an on-going basis. This aircraft is operated by NRC's Institute of Aerospace Research and flies out of Uplands Airport in Ottawa.

The reduced gravity environment is obtained with a specially modified FALCON 20 business jet which flies a parabolic arc (Figure 1) to produce short periods of near zero-g acceleration force. This parabolic manoeuvre is initiated and terminated with a pull-up and pull-out of 2.0 g's. The length of these reduced gravity periods depends on the "g" level required for the specific test. Although the theoretical zero-g time is 23 seconds, experimenters should only count on 15 to 20 seconds of zero-g. See Appendix 1 for details on the low gravity conditions obtained during typical flights.

A typical flight will consist of up to four parabolas. Each of these parabolas is separated by about three minutes or, if required, enough time to alter the test set-up. A normal mission takes approximately 45 minutes from takeoff to landing. Changes to the normal mission can be made to ensure more efficient testing operations.

The FALCON 20 aircraft is equipped to provide electrical power and a data acquisition system. Limited work space is available on the ground for build-up and checkout of test equipment to ensure its operation before installation in the airplane.

The campaigns are organized by the Reduced Gravity Project Officer at the Canadian Space Agency. This individual is responsible for coordinating all aspects of campaign planning from the time that a proposal is accepted. When mention is made of contacting the "CSA" in this document, it refers to contacting the Project Officer.

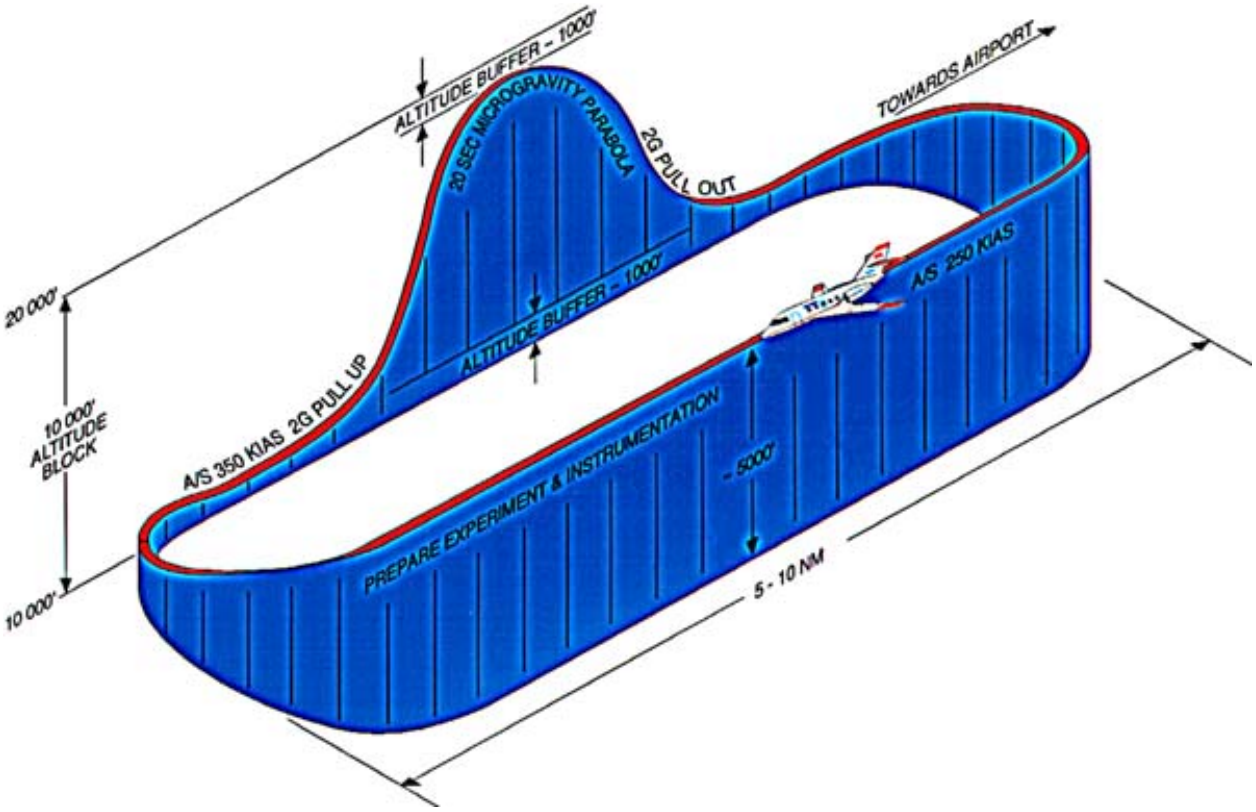


Figure 1. 1 Typical Microgravity Flight Trajectory

2.0 AIRCRAFT FACILITIES PROVIDED

2.1 Environment

Cabin pressure is typically maintained between sea level (14.7 psia) and 1000 ft MSL during the parabolic manoeuvres. However, loss of cabin pressure could result in a cabin pressure as low as 7 psia. This must be considered in the design of the test equipment. Inflight cabin temperature is normally maintained within a comfortable level. On the ground, before and after flight, cabin temperatures can approach (and in summer exceed) outside air temperature. If the experiment is very sensitive to temperature or pressure variation, measures should be taken to minimize the effects.

2.2 Cabin Dimensions

The cabin dimensions are approximately 5m by 1.5m wide and 1.5m high. The floor plan is shown in Figure 2. Depending on the size of the equipment to be installed in the aircraft seating for up to 3 experimenters can be provided.

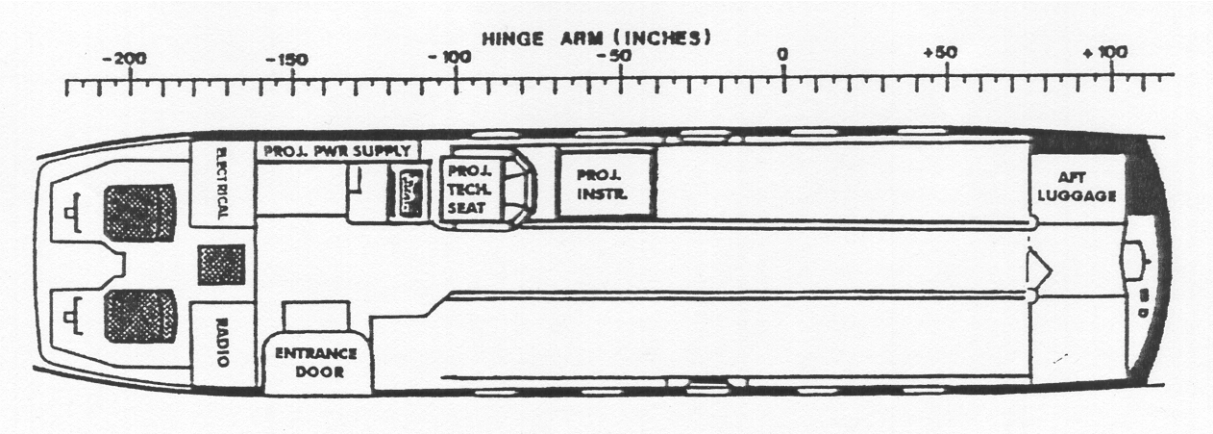


Figure 2. 1 Cabin Dimensions (Plan View)

2.3 Electrical Power and Interfaces

The following electrical power is available in the test section on the aircraft. Some combinations are not available. Please contact FRL to discuss your requirements.

125 amps total	50 amps - 28VDC 50 amps - 28VDC 25 amps - 28VDC	Terminal Block
22.5 amps total	7.5 amps - 60 Hz AC 7.5 amps - 60 Hz AC 7.5 amps - 60 Hz AC	AC Power Cord
7.5 amps total	7.5 amps - 400 Hz AC	See FRL

The aircraft electrical power is distributed to three power distribution panels spaced along the lower side wall of the test section. Bendix type connectors are used in the aircraft. They will be provided to the experimenters during the integration phase of the experiment.

Momentary interruptions of electrical power may occur during flight. Although infrequent, these interruptions may disrupt certain sensitive instruments, and we recommend that test equipment incorporate protection to prevent data loss.

2.4 Acceleration Monitoring & Data Collection

The NRC Falcon aircraft is equipped with an onboard data acquisition system which normally records a wide variety of aircraft parameters. The system records at 16 hz. In addition to recording the 3 axis acceleration levels during flight, the system can accept up to 16 channels of the experimenter's analog data. In order to have data recorded, the experimenter must provide analog signals, scaled not to exceed +/- 10 volts dc to the Falcon data acquisition system. These analog input signals are converted to digital form and recorded on DAT tape. Postflight, recorded information can be provided to the experimenter in the form of hard copy or on 3.5 inch floppy disks.

Principal Investigators interested in using this system should contact the Reduced Gravity Project Officer for further details.

3.0 SAFETY POLICY

The CSA Falcon 20 Reduced Gravity Program is operated in accordance with established NRC and CSA safety procedures. Due to the critical nature of this program, a multistage approval and review procedure has been developed to ensure flight safety. NRC/FRL, the owner-operator of the Falcon 20, has the ultimate responsibility for safety of operation of the aircraft.

3.1 Providing-Centre Requirements

It is the responsibility of the Principal Investigator (PI) to ensure that an experiment meets his or her own institutional safety standards, as well as the standards of the CSA and NRC. Experiments that do not meet these standards will not fly on the FALCON 20.

3.2 Test Personnel

Only those personnel with a demonstrated necessity to participate in the investigation will be allowed to fly in the aircraft during test operations.

Due to the nature of the flights and the fact that the NRC Falcon does not operate under a Transport Canada Certificate of Airworthiness but under Flight Permit, there may be implications regarding applicability of personal life insurance policies. **It is the responsibility of each experimenter to ensure that they possess adequate insurance coverage.**

3.2.1 Medical Requirements

The individuals selected for flight must be medically fit and have passed, in the year preceding the flight (in the 6 months preceding the flight if over age 40), a Transport Canada pilot's physical administered by a physician approved by Transport Canada.

3.3 Test Readiness/Safety Review

The Test Readiness/Safety Review (TRSR) is the final safety review done by CSA and NRC prior to handover to NRC for inspection, integration and flight clearance. It includes a complete review of supporting analyses and documentation, and inspection of the test equipment, and a final integrated verification of flight readiness. The TRSR will approve, approve pending corrections indicated, or not approve the test for flight. A unanimous decision is required for flight approval. Tests which have not been approved may be scheduled for a subsequent review when deficient areas have been corrected. For tests which have been approved pending corrections indicated, another TRSR is not required; however, a test director must verify corrections have been made before the equipment will be loaded on the aircraft. An example of the TRSR Certification Form is included in Appendix 2.

Final approval for flight, including equipment installation in the aircraft and integration with aircraft project systems, if required, will be made by or under the supervision of NRC/FRL personnel in accordance with FRL FR63 Airworthiness and Flight Safety Procedures. (FRL Standard Engineering Practices Manual)

4.0 USER PROCEDURES AND DOCUMENTATION REQUIREMENTS

4.1 Flight Arrangements

If a user has a current contract with the Microgravity Sciences Program (formerly User Development Program), the user is not required to submit a formal proposal to fly the experiment on the FALCON 20. It is sufficient to contact the user's Scientific Authority and request approval to fly the experiment. This request should be made as early as possible. For these researchers who do not have a contract with the Microgravity Sciences Program a formal proposal is required.

Proposal Contents

The following sections are required in the proposal:

(1) Objective of experiment
(2) Description of experiment
(3) Scientific Background
(4) Plans for data analysis
(5) Funding
    - amount requested from CSA (give breakdown)
    - amount provided by experimenter
(6) FALCON 20 requirements (no. of flights/parabolas/personnel, power)
(7) Summary of results from previous FALCON 20 or KC-135 flights, if applicable.
(8) List of recent publications (5 years where relevant). Indicate which of these result from previous flights.

Proposals should contain sufficient information so that they can be reviewed for both quality of science and engineering.

4.2 Human/Biological Research Protocol

Test developers who plan research involving human test subjects or biological tests must obtain approval from the CSA Human Ethics Committee. Six (6) copies of the completed Certificate of Review of Research and Development Protocol Involving Human Subjects (Appendix 3) must be **submitted to the CSA three (3) months prior to the proposed flight date**. Required to be included with this protocol are the equipment safety certification and applicable signed consent forms from each subject. The consent forms (Minimal Risk - Appendix 4 / Reasonable Risk - Appendix 5) are valid for one year.

4.3 Test Equipment Data Package

This documentation -- the Test Equipment Data Package (TEDP) -- includes the test plan, engineering drawings and schematics, structural analysis, electrical load analysis, and an analysis of any identifiable hazards. The test plan should contain (but not be limited to) the following:

a. Synopsis
b. Test objectives
c. Test description
d. Equipment Description (Drawings, schematics, photographs, block diagrams, e.g. structural load analysis
f. Electrical load analysis and electrical circuit diagram, including fuses (if applicable)
g. Pressure vessel certification (if applicable)
h. In-flight test procedures (checklist type is required).
i. Parabola requirements, number, and sequencing
j. Test support requirements, ground and flight
k. Data acquisition system
l. Test operating limits or restrictions
m. Proposed manifest for each flight
n. Photographic requirements
o. Hazard Analysis

The structural load analysis (e.g., above) must show that the apparatus will meet NRC/IAR's structural requirements as specified in the Test Equipment Fabrication Requirements (Appendix 6). For most hardware this analysis can be performed with force calculations or static loading of the hardware.

The hazard analysis (o, above), must demonstrate that the experimenter has considered the potential hazards of his or her experiment and has taken steps to reduce them.

Note: ***Four copies of the Test Equipment Data Package should be submitted to CSA six (6) weeks prior to the flights.***

5.0 SCHEDULING AND TEST OPERATIONS

5.1 Scheduling

The Falcon 20 is normally available year round, however, other operational commitments including maintenance may preclude zero g flights on specific dates. A typical timeline to fly an experiment is as follows:

T-60 days	:	Hardware constructed/ Inspection by CSA/ Tentative flight dates
T-50 days	:	TEDP received at CSA
T-45 days	:	Hardware reviewed by CSA (if required)
T-30 days	:	Flight dates confirmed
T-week	:	Inspection at IAR and integration
T-0	:	Flights

Depending on the nature of the experiment, the hardware used or existing flight arrangements, the schedule will be adjusted.

Flight schedules are dependent upon satisfactory weather conditions and the mechanical fitness of the aircraft. Therefore, due to possible schedule changes, experimenters must not purchase non-refundable airline tickets for approved travel.

5.2 Preflight

5.2.1 Equipment Delivery

The test equipment should be received at NRC/FRL Uplands Airport in a timely manner to allow for build up, inspection, and the Test Readiness/Safety Review.

The build up and checkout of test equipment is the sole responsibility of the experimenter. All tools and checkout equipment must also be provided by the user.

5.2.2 Flight Readiness/Safety Review

The Test Readiness/Safety Review will normally be conducted the day prior to the first flight. The Principal Investigator, or a member of the experimenter's team that is familiar with the hardware, must be present. A simulated ground run may be required during this review whereby the test developer will demonstrate normal and contingency in-flight procedures. If approved for flight by NRC, the equipment will subsequently be loaded on the aircraft.

Reflights of approved equipment do not require an additional Flight Test Readiness/Safety Review unless modifications have been performed.

5.2.3 Experiment Loading

Project equipment will be mounted onto NRC provided frames which will then be mounted to the seat rails in the aircraft cabin. Seat rail maximum loading is 100 lb per linear foot of rail. Mounting rack specifications are shown in Appendix 7. For safety reasons and for ease of loading equipment, experiments weighing more than 100 lb should be disassembled into small sections (maximum weight 100 lb each). Individual sections would then be carried aboard the aircraft and reassembled.

5.2.4 Preflight Briefing

A preflight briefing, prior to boarding, will be given to all flight personnel. The briefing will cover the emergency equipment on-board the aircraft and the emergency egress procedures.

All individuals manifested for flight will be required to sign a NRC Liability Waiver (See Appendix 8) before the flight. Experimenters will be required to bring a copy of their medical exam results to NRC.

5.3 Flight Phase

All personnel on board the aircraft will be under the direction of the aircraft flight crew and NRC/IAR test director, both for normal and emergency conditions and test operations. The NRC test director is in charge of all test activities, and the aircraft commander is the final authority for all operations from engine start through shutdown. Strict adherence to the authority of these personnel will be rigidly enforced. Any deviation from the flight-test plan must be discussed with the test director before implementing.

5.4 Postflight

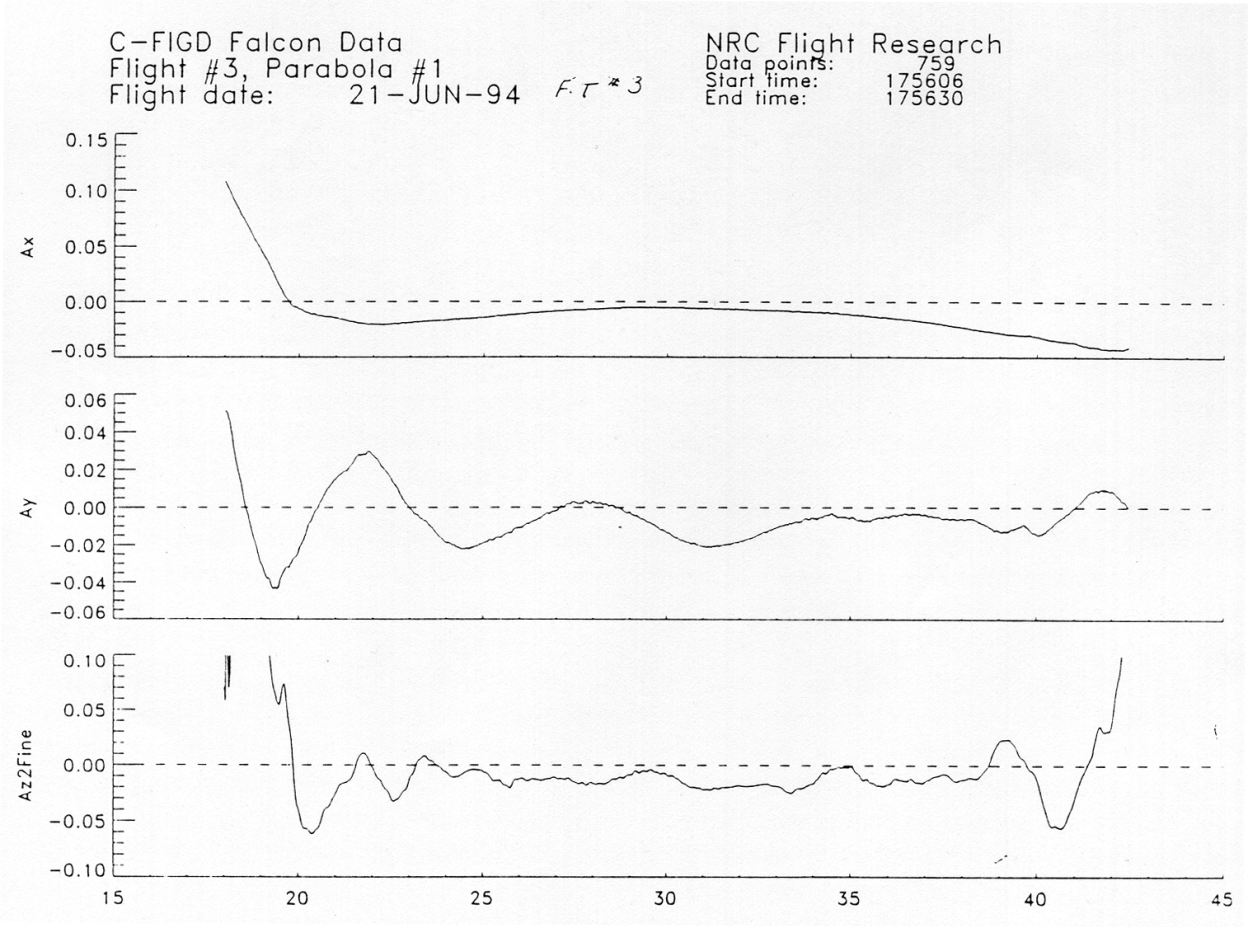
A postflight debriefing will be held immediately after landing to review any problems that occurred during the flight and to discuss possible alterations to the test hardware or test procedures. Upon completion of the test phase, the equipment will be downloaded and prepared for shipment by the user.

6.0 CONCLUDING REMARKS

Flying an experiment on the FALCON 20 is a process that involves the efforts of many individuals.

The degree of detail, rigor, and formality required in the development and conduct of reduced gravity tests depends on the complexity, potential hazards, and uniqueness of the test. Communications with the CSA Reduced Gravity Project Officer are required early and often to eliminate any last minute surprises which may cause delays. The personnel of the Reduced Gravity Office will review and comment on preliminary drawings and plans at any stage of development. It should be noted that a reduced-gravity flight will be conducted only after cognizant NRC/FRL personnel have been assured that a safe, well organized, and productive flight can be achieved.

Appendix 1 - Typical Low Gravity Conditions


C-FIGD Falcon Data
Flight #3, Parabola #1
Flight date: 21-JUN-94
FT#3
NRC Flight Research
Data points: 759
Start time: 175606
End time: 175630
Ax
0.15
0.10
0.05
0.00
-0.05
Ay
0.06
0.04
0.02
0.00
-0.02
-0.04
-0.06
Az2Fine
0.10
0.05
0.00
-0.05
-0.10
15
20
25
30
35
40
45

Appendix 2 - Test Readiness/Safety Review Certification Form

CSA Reduced Gravity Program
Test Readiness/Safety Review Certification (Test Title)

I. The following items have been checked for safety, technical adequacy and audit ability.

1. Science readiness review (apparatus, samples, flight plan, etc).
2. Personnel training, medical qualifications and documentation.
3. Test System.
4. Safety analysis and documentation.
5. Aircraft systems and maintenance.

II. The following items are required to be accomplished prior to test initiation:

A. _____

B. _____

C. _____

III. Test initiation is:

( ) Approved for installation in the NRC Falcon-20
( ) Approved pending corrections indicated in paragraph II
( ) Not Approved

_____	_____
Principal Investigator	Date
_____	_____
CSA Reduced Gravity Officer	Date
_____	_____
CSA Program scientist	Date
_____	_____
CSA Human Ethics Representative (if required)	Date
_____	_____
NRC Microgravity Officer	Date
_____	_____
NRC Safety Officer	Date

NOTE: *Until IAR maintenance has approved the final installation in the aircraft and signed the appropriate aircraft log books, as required by law by Transport Canada, final approval for flight is, technically not granted.*

Appendix 3 – Certificate of Review of Research and Development Protocol Involving Human Subjects

Certificate of Review of Research and Development Protocol Involving Human Subjects

1. **Institution/Firm name:**
2. **Institution/Firm address:**
3. **Title of project:**
4. **Name(s) and affiliation(s) of principal investigator(s):**
5. **Name(s) and affiliation(s) of professional colleague(s):**
6. **Name(s) and affiliation(s) of external collaborator(s): (if applicable)**
7. **Period of research involving human subjects:**

   Estimated Date Of Commencement:

   Estimated Date of Completion:

8. **Description of proposed research and development: (This section must include at least the following information)**

   a) State the purposes and specific objectives of the research and development in a language and in wording that the human subjects can understand.

   b) Demonstrate the scientific validity and quality of the proposal

   c) Explain why the use of human subjects is necessary at this time. Indicate if all other possible alternatives have been explored.

   d) Explain how the participants are to be selected, and provide a justification for the number of participants.

   e) Describe the research and development procedures that will be followed including information on how long they will take and on their frequency. Explain which of the procedures are done for research and development and which ones are standard practice, and give full information regarding any drugs to be taken.

   f) Where appropriate, describe criteria for human exposure to the same or similar agents, stimuli or conditions accepted elsewhere.

   g) Indicate if any follow-up studies or procedures are planned.

h) Describe any inconveniences, discomforts, behavioral changes and/or side effects that can be expected.

i) Describe any aspect of the proposed research and development likely to be controversial or delicate.

j) Describe possible risks to the subject, group of subjects or society, including both physical and psychological risks, and including the possibility of jeopardizing the subject's social position (the amount of detail required will be relative to the frequency, severity and reversibility of the risk).

k) Describe possible benefits to society and to the subject, where appropriate – it should be stated that there may be no guarantee or promise of benefits.

l) Indicate if the research and development would involve keeping records on individuals over long periods of time, and indicate how the privacy of the subject would be protected under those conditions.

m) Provide any other relevant information about the research and development which could be expected to influence a person in deciding whether or not to give consent. In particular, tell the subject if you are not covered by liability insurance that would provide he or she with adequate protection if the subject suffered death or injury as a result of his or her participation in the research and development.

n) Make the potential subject well aware that you reserve the right to end his or her participation in the research and development project for ethical, scientific or financial reasons.

o) Make the potential subject well aware that he or she is free to withdraw consent and discontinue participation in the research and development at any time and for any reason without prejudice.

p) Make potential subjects aware of the provisions which would protect their privacy and the confidentiality of their personal information.

q) Provide any additional information relevant to the safety of the subject or requested by the Committee.

9. Name of supervising medical doctor: (if applicable)

10. Affiliation (hospital, etc., if applicable):

11. Name of contact person: (Please provide the name, telephone and Fax number of a person who could be contacted for additional information)

12. Building/laboratory location of human research and development:

13. *Human Subjects Research Ethics Committee* which has reviewed protocol:

a) **name of Committee: *Canadian Space Agency Human Subjects Research Ethics Committee***

b) names and titles of members

c) list of documents submitted to Committee

d) date and place of *Human Subjects Research Ethics Committee* meeting(s)

The *Human Subjects Research Ethics Committee*, together with the undersigned principal investigator and the firm involved in this project, have examined the research and development portion of the application for an CSA contribution in support of the above-mentioned project, on matters relating to procedures involving human subjects and certify that:

a) the principal investigator and the collaborating staff have read the booklet "Guidelines on Research Involving Human Subjects" issued by the *Medical Research Council* (1987);

YES ( ) NO ( )

b) the ethics committee is a recognized *Human Subjects Research Ethics Committee* of an accredited or approved Canadian university teaching hospital or university;

YES ( ) NO ( )

c) the procedures to be used will conform with the protocol shall be referred to the *Human Subjects Research Ethics Committee*;

YES ( ) NO ( )

d) any significant changes to the protocol shall be referred to the *Human Subjects Research Ethics Committee* which has reviewed the protocol, for consideration, and will only be undertaken if approved in writing;

YES ( ) NO ( )

e) this is the first involvement of the firm in research and development involving human subjects;

YES ( ) NO ( )

f) human testing shall be conducted under the direction of a qualified medical practitioner;

YES ( ) NO ( )

g) human subjects shall sign a consent declaration indicating that they have freely agreed to participate on the basis of: **YES ( ) NO ( )**

I. well understood, accurate and adequate information regarding their involvement and the nature, objectives, harms, risks, benefits, and potential benefits of the research and development, and;

II. where controlled trials are part of the research and development methodology, these have been fully explained, in particular, method of selecting subjects for various of the trial, and;

III. their clear understanding of their right to withdraw consent and discontinue participation in the research and development at any time, without prejudice;

h) the subject will be given at least 24 hours to reflect upon the information;

YES ( ) NO ( )

i) a contact person is available to answer any questions or concerns of the subject;

YES ( ) NO ( )

j) attached is a sample copy of the Consent Form signed by each research subject and the Confirmation of Provision of Information;

YES ( ) NO ( )

k) the firm agrees to provide CSA with a copy of all consent forms signed by the subjects and the Confirmation of Provision of Information, as and when requested, and;

YES ( ) NO ( )

l) The firm has adequate insurance to cover losses or injuries that subjects may suffer as a result of their participation as research and development subjects due to negligence on the part of the investigators.

YES ( ) NO ( )

m) The investigators will inform the subjects about the resources available to compensate subjects for other losses or harms caused by their participation in the research and development as human subjects (excluding investigator negligence).

YES ( ) NO

***NOTE**: Indicate your compliance with each condition above by placing a check mark in the corresponding box.*

It is understood that for any contribution or contract arrangement, no work can commence involving human subjects until protocols have been approved by the Canadian Space Agency (CSA) in writing. Portions of the work that do not involve human subjects may commence before that approval. The release of funds is contingent upon continued compliance with the above procedures, including changes to the Description of Research and Development.

_____	_____
Principal Investigator responsible for the human subjects protocol	Date
_____	_____
Chairperson of *Human Subjects* Research Ethics Committee	Date
_____	_____
Official of the firm	Date

Appendix 4 – Consent Form for Approved CSA Human Minimal Risk

Consent Form
for Approved CSA
Human Minimal Risk Research

1. I, the undersigned, do voluntarily give my informed consent for my participation as a test subject to the following test, experiment, or other evaluative procedure:

   NAME OF EXPERIMENT _____

   TRAINING TOUR NUMBER (PROPOSED FLIGHT DATES)_____

   FLIGHT TO WHICH ASSIGNED: CSA REDUCED GRAVITY PROGRAM___

   NAME OF DESIGNATED PRINCIPAL INVESTIGATOR_____

   NAME OF RESPONSIBLE CSA PROJECT SCIENTIST_____

I understand that:

(a) This procedure is part of an experiment approved by CSA.

(b) I am performing these duties as part of my employment, with

_____.

(c) This procedure has been reviewed and approved by the CSA Human Research Policy and Procedures Committee (HRPPC) and determined that the procedure involves no more than minimal risk to the subject.

(d) "Minimal risk" means that the risk of harm anticipated in the proposed research is greater than that ordinarily encountered in daily life or during the performance of routine tests, but considered to be proper when weighing the anticipated benefits and the importance of the knowledge to be gained from the research.

(e) The procedure has been explained to me prior to the execution of this form. I was afforded an opportunity to ask questions, and all questions asked were answered.

(f) I am medically qualified to participate in the procedure.

(g) I may withdraw from the procedure at any time unless, as recommended by the Principal Investigator, or his/her designee, the withdrawal is dangerous or impossible.

(h) In the event of physical injury resulting from the procedure and calling for immediate action or attention that CSA will provide, or cause to be provided, the necessary treatment. My agreement to participate shall not be construed as a release of NASA or any third party from any future liability which may arise from, or in connection with, the above procedures.

2. I, the undersigned Principal Investigator of the experiment designated above, certify that:

(a) I have accurately described the procedure to the test subject.

(b) The test set up involves minimal risk to the test subject. All equipment used has been inspected and certified for safe and proper operation.

(c) The test subject is medically qualified to participate.

(d) The test protocol has not been changed from that approved by the CSA Human Research Policy and Procedures Committee (HRPPC).

APPROVED:

_____	_____
Test Subject	Date
_____	_____
Principal Investigator	Date
_____	_____
Project Scientist	Date

This form is valid for a 60-day period from the date of signature by the subject and the Principal Investigator (which dates should be identical). A signed, dated copy of the form should be given to the CSA Reduced Gravity Officer before the flight to take place.

Appendix 5 – Consent Form for Approved CSA Human Reasonable Risk

Consent Form
for approved CSA
Human Reasonable Risk

1. I, the undersigned, do voluntarily give my informed consent for my participation as a test subject to the following test, experiment, or other evaluative procedure:

   NAME OF EXPERIMENT_____

   TRAINING TOUR NUMBER (PROPOSED FLIGHT DATES)_____

   FLIGHT TO WHICH ASSIGNED CSA REDUCED GRAVITY PROGRAM___

   NAME OF DESIGNATED PRINCIPAL INVESTIGATOR_____

   NAME OF RESPONSIBLE NASA PROJECT SCIENTIST_____

I understand that:

(a) This procedure is part of an experiment approved by CSA.

(b) I am performing these duties as part of my employment, with

_____.

(c) This procedure has been reviewed and approved by the CSA Human Research Ethics Committee and determined that the procedure involves no more than reasonable risk to the subject.

(d) "Reasonable risk" means that the risk of harm anticipated in the proposed research is greater than that ordinarily encountered in daily life or during the performance of routine tests, but considered to be proper when weighing the anticipated benefits and the importance of the knowledge to be gained from the research.

(e) The procedure has been explained to me prior to the execution of this form. I was afforded an opportunity to ask questions, and all questions asked were answered.

(f) I am medically qualified to participate in the procedure.

(g) I may withdraw from the procedure at any time unless, as recommended by the Principal Investigator, or his/her designee, the withdrawal is dangerous or impossible.

(h) In the event of physical injury resulting from the procedure and calling for immediate action or attention, that CSA will provide, or cause to be provided, the necessary treatment. My agreement to participate shall not be construed as a release of CSA or any third party from any future liability which may arise from, or in connection with, the above procedures.

2. I, the undersigned Principal Investigator of the experiment designated above, certify that:

(a) I have accurately described the procedure to the test subject.

(b) The test setup involves reasonable risk to the test subject. All equipment used has been inspected and certified for safe and proper operation.

(c) The test subject is medically qualified to participate.

(d) The test protocol has not been changed from that approved by the CSA Human Ethics Committee.

APPROVED:

Test Subject	Date
Principal Investigator	Date
Project Scientist	Date

This form is valid for a 60-day period from the date of signature by the subject and the Principal Investigator (which dates should be identical). A signed, dated copy of the form should be forwarded to the CSA Reduced Gravity Officer.

Appendix 6 – Test Equipment Fabrication Requirements

Test Equipment Fabrication Requirements

Test equipment intended for use in flight must conform to the following requirements. These requirements are separate from those required by the providing centres' safety organizations. In the event a conflict occurs, the most stringent requirement will be used. All calculations and certifications required in this section should be included in the test equipment data package.

Proposal

All test equipment provided by the using organization must be constructed to the following flight loads:

a. Forward (eyeballs out) - 9 g's
b. Aft (eyeballs in) - 1.5 g's
c. Lateral (eyeballs left and right) - 3 g's
d. Up (eyeballs up) - 3 g's
e. Down (eyeballs down) - 6 g's

These forces should be calculated for the test equipment in its takeoff and landing configuration. Structural calculations for the takeoff and landing configuration may be based on the ultimate strength of the hardware. The in-flight test configuration should be designed for a possible 2.5-g force at manoeuvre entry and exit.

Each structural analysis must includes, as a minimum:

1. Structural drawing or diagram
2. Stress calculations results (if in table form, at least one sample calculation must be given). (A pull test, with applied force equal to g-level x component weight is also acceptable)
3. Weights of components
4. Material properties

Pressure Vessel Certification

All pressure vessels and pressurized systems used in the Reduced Gravity Program shall be certified as safe to operate before use and shall be re-certified periodically after initial certification if periodic re-use is anticipated. This certification includes verification that the pressure vessel/system has been inspected by a pressure system engineer, relief valves in the system are at appropriate locations, relief valves are certified, all pressure gauges are calibrated and appropriate proof tests performed.

Each pressure vessel and pressurized system shall be designed to 4x Maximum Allowable Working Pressure (MAWP), fabricated, and certified (to 1.5 MAWP) in accordance with applicable national consensus codes such as the American Society of

Mechanical Engineers' (ASME's) Boiler and Pressure Vessel Code or other codes acceptable to the NRC/FRL Design Office.

It is the responsibility of the test developer to provide the documentation necessary to prove the certification of the pressure vessels and pressurized systems. This documentation will be reviewed by the Reduced Gravity Office.

The following is a recommended outline for pressure vessel certification as required in the test equipment data package.

1. **System drawing or sketch, dated and initiated by designing engineer.**
2. **Component identification data:**
   a. Relief Devices - Pressure rating, set pressure, manufacturer, model number, and system component number of all relief devices. Each valve should be tagged to indicate its set pressure.
   b. Component (valves, filters, regulators, check valves, etc.), manufacturer, model number and pressure rating, and system component number. Regulators should be tagged with a certification verification, and all pressure gauges should be calibrated and labelled as such.
   c. Flex hoses - Pressure rating, size, and system component number.
   d. Pipe and Tubing - Material, size, and schedule or thickness (and pressure rating if available).
   e. Pressure Vessels -
      (1) Drawings or specifications that as a minimum specify:
         (a) Maximum Allowable Working Pressure (MAWP)
         (b) Material thickness
         (c) Material specification
         (d) Head and shell geometry
         (e) Weld joint geometry

      (2) Serial number or unique identifying number.

      Note: If vessel is ASME or Department of Transportation (DOT) certified, nameplate or stamped data will fulfil the requirements of (1) and (2) above.

      (3) Certification Tests
         (a) Pressure Vessels

         All pressure vessels require proof-pressure testing. Hydrostatic testing at 1.5 MAWP is the preferred method of accomplishing this test. Pneumostatic testing at 1.25 MAWP may be performed, except on DOT vessels, which must be hydrostatically tested.
         (b) Relief Valves

All relief valves require set-pressure testing. The set pressure of the relief valve in no case shall exceed the MAWP of the system.

(c) Flex Hoses
All flex hoses require proof-pressure testing. The only acceptable method of testing flex hoses is a hydrostatic test at 1.5 MAWP.

(d) System Piping
All system piping requires proof-pressure testing. Hydrostatic testing at 1.5 MAWP is the preferred method of accomplishing this test. Pneumostatic testing at 1.25 MAWP may be performed.

3. Inspection Reports - The most current system and component inspection forms and proof-test documentation will be provided.

Free-Float Packages

No free floating will be allowed in the FALCON 20.

Hazardous Materials

Hazardous liquids and gases where possible, including high-pressure, toxic, corrosive, or explosive, and flammable materials will not normally be carried on the NRC Falcon 20. If such materials are required for a test, early contact with the CSA Reduced Gravity Office for possible discussions on use are recommended. A current MSDS must be supplied for each hazardous material.

NOTE: The cabin volume is 500 ft^3 (14,2 m^3). The cabin air exchange varies.

Laser Applications

Any application of lasers must comply with the requirements of ANSI Z136.1, and Title 21, U.S. Code of Federal Regulations, Subpart J.

Miscellaneous Guidelines

a. Avoid sharp edges and corners on all equipment. All exposed edges and corners, sharp or not, should be padded.

b. DO NOT USED LIQUID electrolyte- or lithium-type batteries (battery circuits may require analysis by battery experts to avoid shock, shorts, or overheating). Whenever possible, use dry cells or zinc air batteries.

Alkaline or Ni-Cad batteries are also acceptable, but the Ni-Cads must not be charged in flight.

c. Avoid flammable materials in test article construction. Any test article with electrical or heat or spark-producing equipment cannot use flammable materials, such as plywood, in its construction. (Exception: Use of plywood for weight distribution or as a baseplate for a laptop computer or similar device is acceptable. Any other arrangement will be coordinated with the Reduced Gravity Office).

d. Consider equipment or procedural failures. Provide backups or workarounds to prevent such failures from causing hazards to personnel or aircraft.

e. Consider the activities required to be performed during the 2-g and zero-g portions of the parabolic manoeuvres. Structure activities so as to minimize movement during the high-g manoeuvres. Consider the need to use handholds during the zero-g portions (but remember that this can result in perturbations to the experiments if handholds are part of hardware).

f. All exposed parts must be kept to a temperature that is safe to touch. Cover any hot parts.

g. Tie or tape down any loose cables.

h. For delicate hardware, a protective structure should be provided in case a floating object falls on the equipment.

i. Cover any glass monitor screen with Lexan or Plexiglass.

j. Experimenters should plan ahead to minimize the amount of set-up time requires when loading the hardware on to the aircraft.

Optional Items

a. Hand-holds for the operators are very useful, as the operators may at times be unrestrained.

b. If the experiment requires the changing of film or samples, provide a container to hold these items so they don't float away. The container should be attached to your hardware.

c. In order to minimize motion sickness your experiment should be designed to minimize the operator's head movements during the two-g pull-out. Extensive head motions during zero-g can also provoke motion sickness.

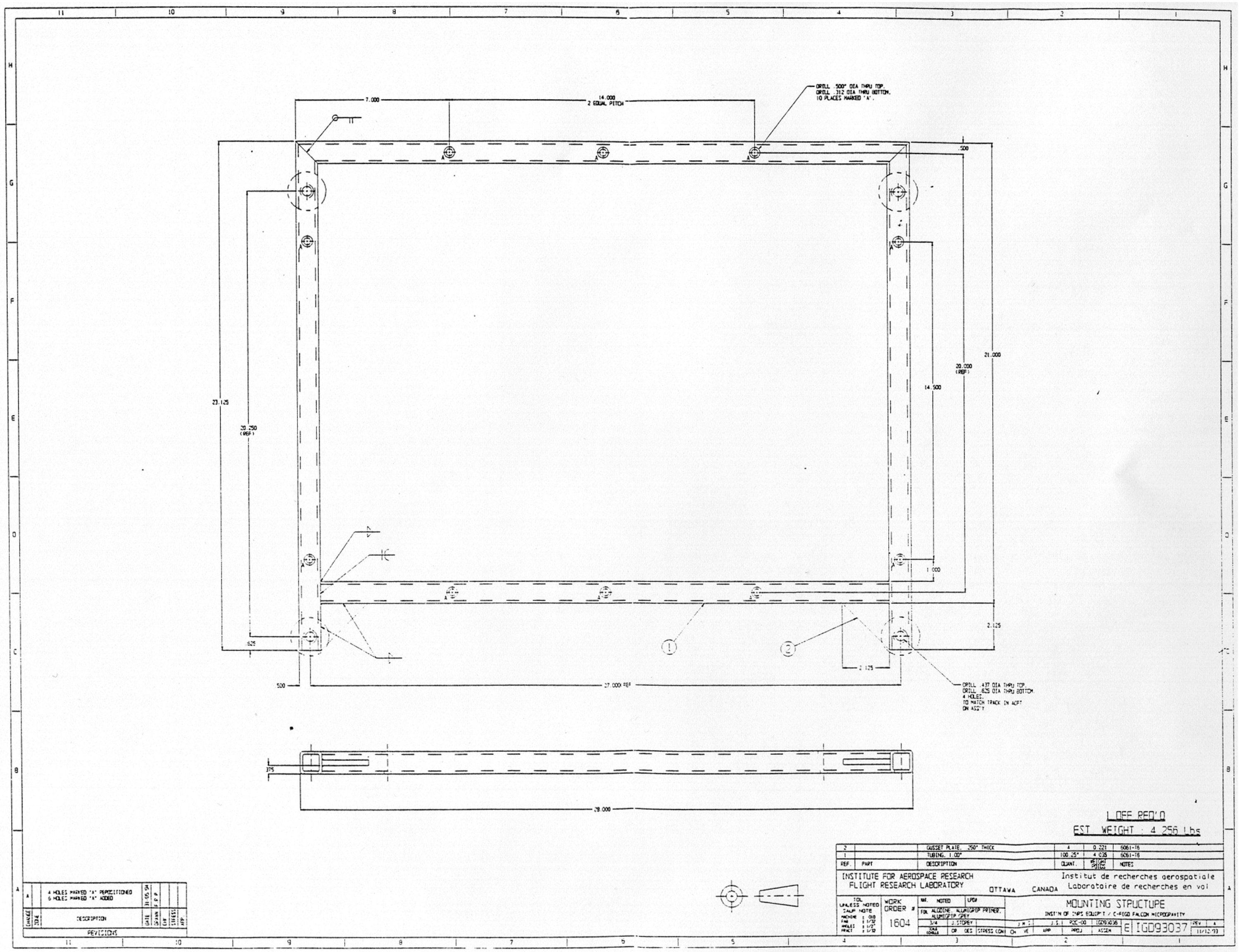
d. A small audiocassette recorder is useful for the operator to make comments on. It should be attached to the experiment with duct tape. Writing of results is difficult and slower.

e. Any tools required should be attached to your experiment with velcro or duct tape.

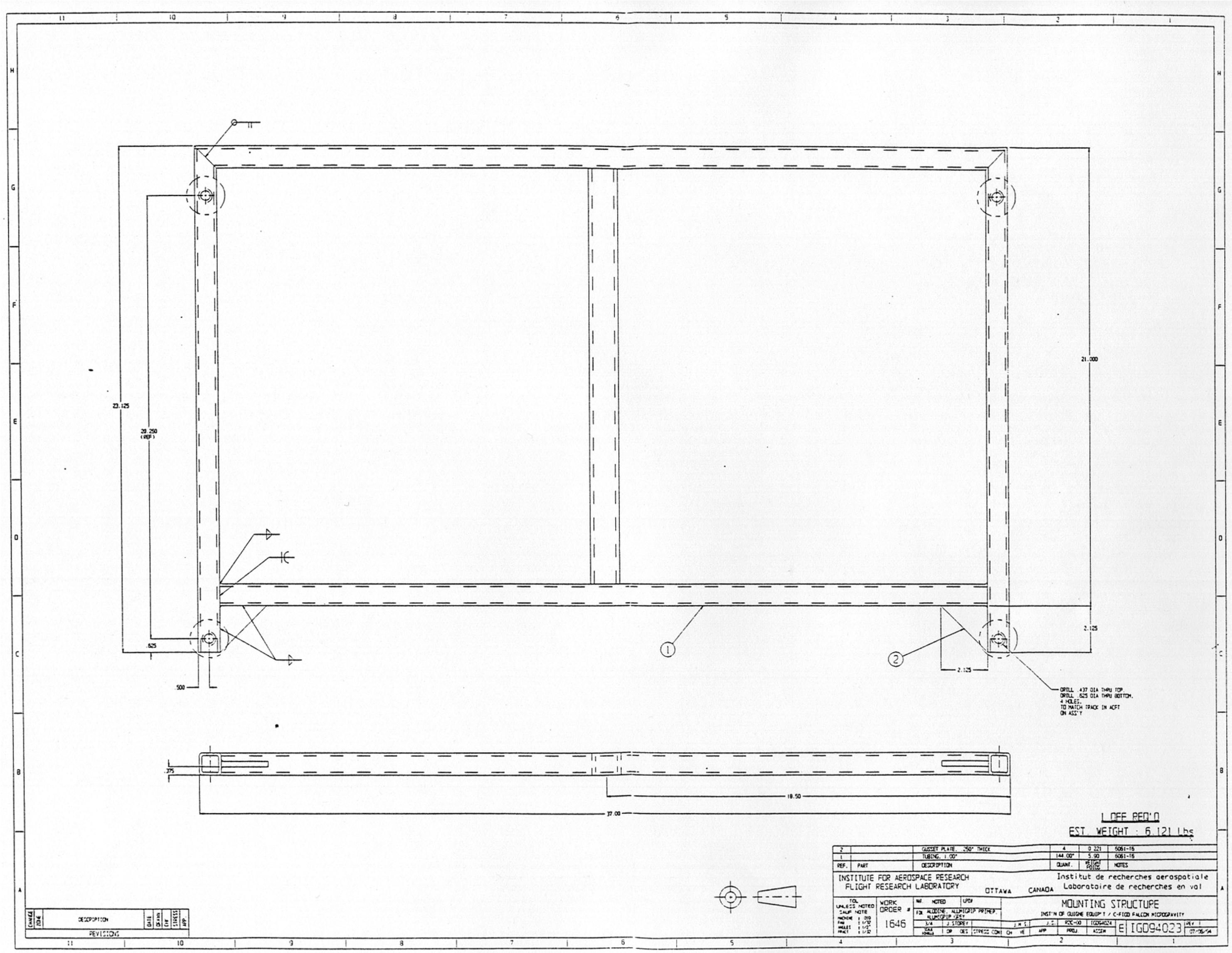
f. Experimenters with video camera should put in their flight check-list a reminder to periodically monitor their camera to make sure power glitches have not reset the camera to the "RECORD" to "STANDBY" mode.

g. Experimenters who fly video cameras should be aware that NRC will normally require a strap over the camera.

Appendix 7A – Single Mounting Rack Specifications

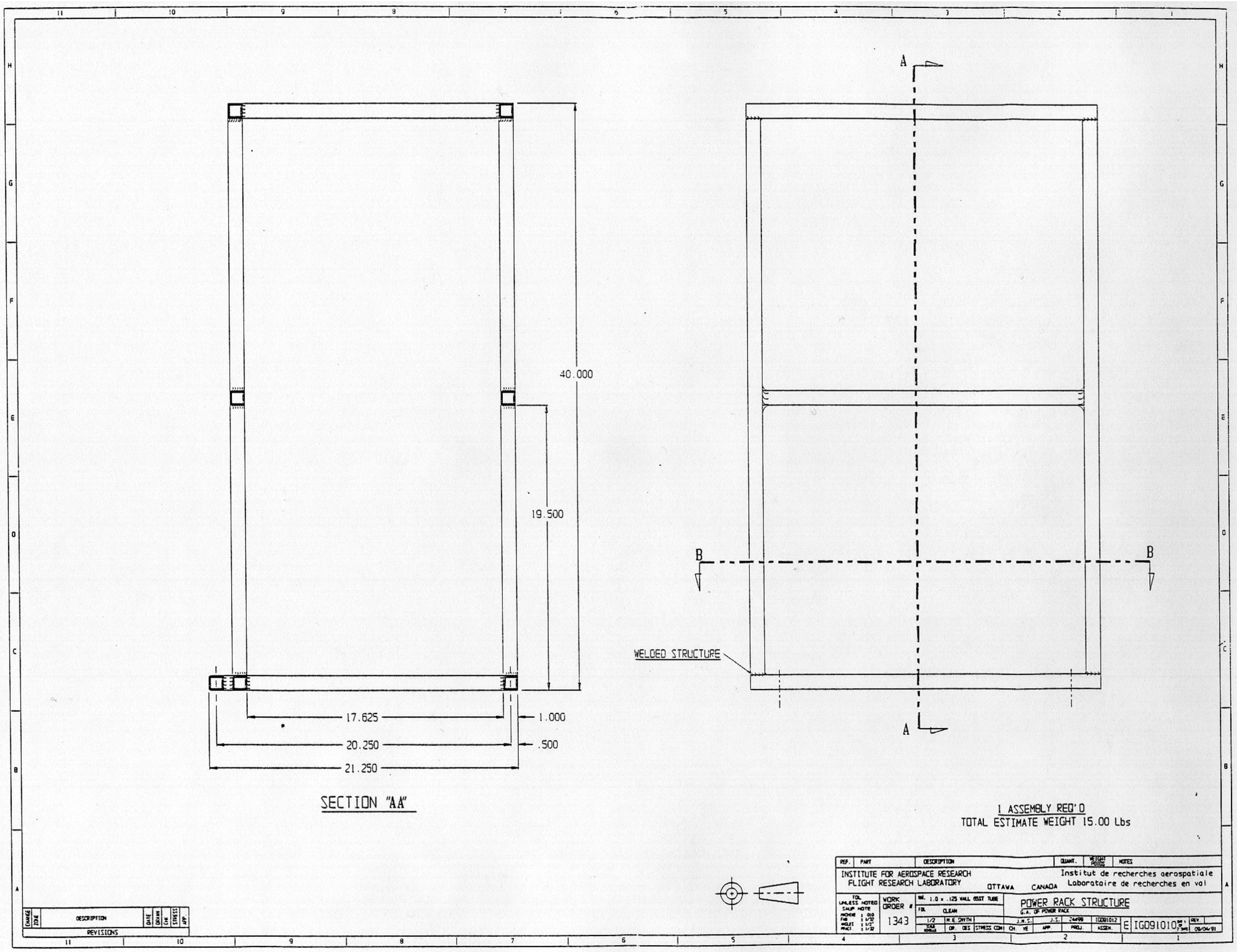

7.000
14.000
2 EQUAL PITCH
DRILL .500" DIA THRU TOP.
DRILL .312 DIA THRU BOTTOM.
10 PLACES MARKED 'A'.
.500
23.125
20.250 (REF)
20.000 (REF)
21.000
14.500
1.000
2.125
.625
.500
27.000 REF
DRILL .437 DIA THRU TOP.
DRILL .625 DIA THRU BOTTOM.
4 HOLES.
TO MATCH TRACK IN ACFT
ON ASS'Y
.375
28.000
1 OFF REQ'D
EST. WEIGHT : 4.256 Lbs
2 GUSSET PLATE, .250" THICK 4 0.221 6061-T6
1 TUBING, 1.00" 100.25" 4.035 6061-T6
REF. PART DESCRIPTION QUANT. WEIGHT POIDS NOTES
INSTITUTE FOR AEROSPACE RESEARCH
FLIGHT RESEARCH LABORATORY
OTTAWA CANADA
Institut de recherches aerospatiale
Laboratoire de recherches en vol
TOL. UNLESS NOTED SAUF NOTE
MACHINE ±.010
FAB ±1/32
ANGLES ±1/2°
FRACT ±1/32
WORK ORDER # 1604
MAT. NOTED
FIN. ALODINE, ALUMIGRIP PRIMER, ALUMIGRIP GREY
MOUNTING STPUCTUPE
INST'N OF INPS EQUIP'T / C-FIGD FALCON MICROGRAVITY
3/4 J. STOREY
J.S. P2C-00 IGD93036
SCALE ECHELLE DR. DES STRESS CON CH VE APP PROJ ASSEM
E IGD93037
REV A
11/12/93
A 4 HOLES MARKED "A" REPOSITIONED
6 HOLES MARKED "A" ADDED
31/05/94
CHANGE ZONE DESCRIPTION DATE DRAWN CHK STRESS APP.
PEVISIONS

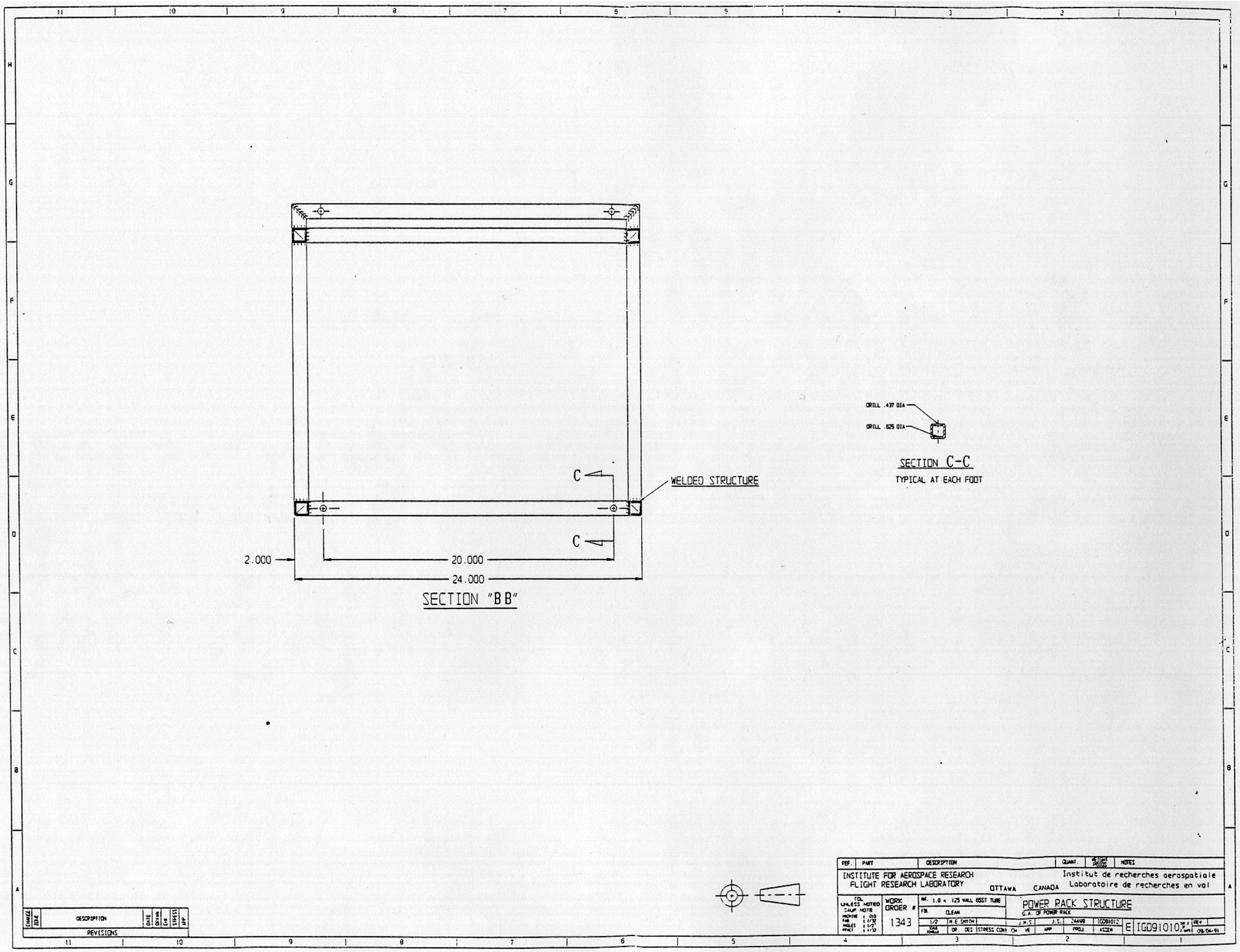
Appendix 7B – Double Mounting Rack Specifications



23.125
20.250 (REF)
21.000
2.125
.625
.500
.375
18.50
37.00
1
2
DRILL .437 DIA THRU TOP.
DRILL .625 DIA THRU BOTTOM.
4 HOLES.
TO MATCH TRACK IN ACFT
ON ASS'Y
1 OFF REQ'D
EST. WEIGHT : 6.121 Lbs
2 GUSSET PLATE, .250" THICK 4 0.221 6061-T6
1 TUBING, 1.00" 144.00" 5.90 6061-T6
REF. PART DESCRIPTION QUANT. NOTES
INSTITUTE FOR AEROSPACE RESEARCH
FLIGHT RESEARCH LABORATORY
OTTAWA CANADA
Institut de recherches aerospatiale
Laboratoire de recherches en vol
WORK ORDER #
1646
MOUNTING STRUCTURE
J. STOREY
E IGD94023
REVISIONS
DESCRIPTION

Appendix 7C – Power Rack Specifications


A
A
B
B
40.000
19.500
17.625
1.000
20.250
.500
21.250
SECTION "AA"
WELDED STRUCTURE
1 ASSEMBLY REQ'D
TOTAL ESTIMATE WEIGHT 15.00 Lbs
REF.
PART
DESCRIPTION
QUANT.
NOTES
INSTITUTE FOR AEROSPACE RESEARCH
FLIGHT RESEARCH LABORATORY
OTTAWA CANADA
Institut de recherches aerospatiale
Laboratoire de recherches en vol
WORK ORDER #
1343
1.0 x .125 WALL 6SST TUBE
CLEAN
1/2
M.E. SMYTH
STRESS COM
J.M.S.
J.S.
24499
IGD91012
POWER RACK STRUCTURE
G.A. OF POWER RACK
E
IGD91010
REV.
09/04/91
DESCRIPTION
REVISIONS


C
C
WELDED STRUCTURE
2.000
20.000
24.000
SECTION "BB"
DRILL .437 DIA
DRILL .625 DIA
SECTION C-C
TYPICAL AT EACH FOOT
REF.
PART
DESCRIPTION
QUANT.
WEIGHT POIDS
NOTES
INSTITUTE FOR AEROSPACE RESEARCH
FLIGHT RESEARCH LABORATORY
OTTAWA CANADA
Institut de recherches aerospatiale
Laboratoire de recherches en vol
TOL UNLESS NOTED
WORK ORDER #
1343
1.0 x .125 WALL SST TUBE
CLEAN
POWER RACK STRUCTURE
G.A. OF POWER RACK
1/2
M.E. SMYTH
J.M.S.
J.S.
24499
IGD91012
DR.
DES
STRESS
CH
VE
APP
PROJ
ASSEM
E
IGD91010
REV
09/04/91
DESCRIPTION
REVISIONS

Appendix 8 – NRC Liability Release Form

National Research Council Canada
Conseil national de recherches Canada

Institute for Aerospace Research
Institut de recherche aérospatiale

Flight Research Laboratory
Laboratoire de recherches en vol

Ottawa, Canada
K1A 0R6

NRC · CNRC

46-7305-0-2

RELEASE

KNOW ALL MEN BY THESE PRESENTS, that I
(*name and address releasor*)

_____
_____
_____

for myself, my heirs, administrators, executors and assigns in consideration of the National Research Council of Canada (the Council) granting me permission to be in and about the premises of the Council or to travel on aircraft (including helicopters) owned or operated by the Council during the period commencing on the ___ day of _____ 20 ___ and ending on the ___ day of _____ 20 __, do hereby remise, release and forever discharge the Council, Her Majesty in right of Canada, and their officers, employees, and agents from all manners of action, claims or demand of whatever kind or nature that I ever had, now have or can, shall or may hereafter have by reason of loss or damage to property or personal injury (including injury resulting in death) or both as a result of or in any way arising out of the permission granted whether due to tort or otherwise.

I understand that the aircraft does not have a Certificate of Airworthiness, and is normally operated under a Flight Permit issued by Transport Canada.

IN WITNESS WHEREOF, I have hereunto set my hand and seal this ___ day of _____ 20 ___.

SIGNED, SEALED and DELIVERED
In the presence of

_____ _____
WITNESS **RELEASOR**

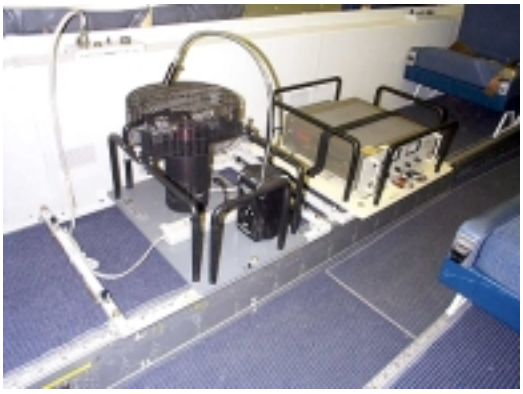
I authorize the above mentioned to fly on the _____ aircraft as a crewmember for the _____ project.

Emergency Contact (name & phone #)

_____ Director, FRL _____
_____ Date _____

Canada

Appendix 9 – Experiments Mounted in Aircraft (Photos)



Experiments Mounted in Falcon 20