CSA-iFTS-SOW-0002

Canadian Space Agency

Space Science & Technology

CALIBRATION AND VALIDATION OF THE IMAGING FOURIER TRANSFORM SPECTROMETER (IFTS) ON A STRATOSPHERIC BALLOON

STATEMENT OF WORK

REVISION B

DATE: 2021-01-19

NCAGE Code: L0889

Canadian Space Agency | Agence Spatiale Canadienne

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1 INTRODUCTION

1.1 PURPOSE

The purpose of this document is to provide the definition of the work to be performed for the sub-orbital demonstration activities of the elegant breadboard (EBB) of an imaging Fourier Transform Spectrometer (iFTS) to be deployed on a gondola for the Stratospheric Balloon Demonstration. This document provides the requirements and deliverables for the scientific work associated to the above mentioned demonstration.

The vendor performing the work shall be hereinafter referred to as the 'Contractor'.

1.2 CONTENT

This Statement of Work defines the manner in which the work is to be performed and controlled. The following topics are covered:

- Project Management
- Science
- Meetings and Reviews
- Deliverables

1.3 GENERAL AND BACKGROUND INFORMATION

An imaging Fourier Transform Spectrometer (iFTS) for climate observations is an optical payload that acquires spectral images for providing a map of total column abundance of the key greenhouse gases linked to climate change. As motivated by identified User Needs within Environment and Climate Change Canada (ECCC), as well as internationally, this instrument is expected to demonstrate the technology for improving the combination of spatial resolution, coverage, and precision when compared to previous generations of related technology. This emerging technology domain is suitable for the global monitoring of emissions, and addressing outstanding uncertainties in the dynamic carbon budget of the planet. The goal of a space-based iFTS instrument is to inform the development of evidence-based policies to monitor emissions, consistent with the Government of Canada Innovation Agenda.

CSA will coordinate the last adaptations required for the stratospheric balloon gondola under a separate contract called the iFTS advancement for balloon flight led by an industrial contractor. Some tasks dedicated to the industrial contractor have been included in the current SOW to clarify roles and responsibilities. The vendor performing the work described in the iFTS advancement for balloon flight SOW will be hereinafter referred to as the 'industrial contractor' as opposed to the 'Contractor' as above-mentioned in section 1.1. The duration of the iFTS advancement for balloon flight contract is similar to the duration of the current SOW. Nevertheless, the adapted instrument will be delivered to the Contractor according to the schedule indicated in this SOW to allow for instrument calibration and validation.

1.4 OBJECTIVES

iFTS technology for climate observations requires a demonstration from stratospheric altitudes to confirm the ability of this emerging technology to achieve the precision, coverage, and spatial

resolution required to satisfy identified User Needs related to monitoring and predicting the global carbon cycle from a near-space environment.

This contract is focused on the calibration and validation activities that are required for the demonstration of the iFTS instrument design on a balloon platform for a float altitude from 30–40 km. The flight is projected to be held in August 2022.

1.5 SCOPE

In the development of the previous CSA STDP contract, an iFTS EBB has been built, which will be provided for this contract as Government Furnished Equipment (GFE).

In the development of the previous CSA STDP contract, the iFTS EBB was designed keeping in mind that its end use would be a technological demonstration via a stratospheric balloon flight. When possible, components have been selected for their compatibility with the demanding environmental conditions associated with balloon flights.

The scope of this investment is thus focused on the demonstration of advanced Canadian capacity to measure total column abundance CO_2 and/or CH_4 with sufficient spatial resolution, coverage and precision to meet identified domestic and international User Needs.

Need	What is in Scope	What is out of Scope
Technology: Demonstration of an emerging technology domain	• System level demonstration of measurement technique • Validate System Requirements connection to User Needs • Sub-orbital demonstration of ability to meet User Needs.	• Fully qualified space instrument • Compromises can be made on coverage as a result of platform selection (i.e. limited altitude)

1.5.1 Project Milestones and Schedule

This section summarizes the schedule of activities. For planning purposes, the date of Contract Award (CA) can be assumed to be in the fall of 2020. The milestone dates given are a maximum limit.

TABLE 1 - MILESTONE REVIEWS

Milestones	Description	Completion	Location
M1- KOM	Kick-off meeting	CA + 2 weeks	Telecon led by Contractor
M2- DDR	Detailed Design Review (DDR)	KOM + 1 month	Telecon led by industrial contractor

Milestones	Description	Completion	Location
M3-TRR	Test Readiness Review (TRR)	DDR+ 9 months	Telecon led by Contractor
M4- PSR	Pre-shipment Review (PSR)	June 15, 2022	Contractor
M5- FRR	Flight Readiness Review (FRR)	August 2022	Timmins
M6- Balloon Demonstration	iFTS Balloon Demonstration	August 2022	Timmins
M7- Data Analysis and Validation	Data Analysis and Validation	M6 + 11 months	Contractor
M8 – Final Review Meeting	Final Review meeting for the iFTS instrument calibration and validation	M7 + 2 months	CSA lead by Contractor

TABLE 2 - MEETINGS

Meetings	Date
iFTS Team Teleconference Meeting	Monthly

Note that baseline for project status meetings is monthly but CSA reserves the right to increase the frequency to biweekly if required.

1.6 ASSUMPTIONS

1.6.1 Language

As English is the standard oral and written language for design, development, operation and utilization of space projects, the Contractor shall use English for this Work, and for exchanges with CSA, along with System International (SI) units.

1.6.2 Document Convention

The following modal verbs, as used in this document, have the specific meaning as indicated below:

"shall"	Indicates a mandatory requirement.
"should"	Indicates a preferred, but not mandatory alternative.
"may"	Indicates an option.
"will"	Indicates a statement of intention.

1.7 ROLES & RESPONSIBILITIES

The Canadian Space Agency (CSA) is the customer for this instrument demonstration. As such, the CSA has the technical authority on all matters concerning this study. The contractor shall perform the tasks as outlined in this SOW and shall deliver the end items defined by this SOW.

2 DOCUMENTS

2.1 APPLICABLE DOCUMENTS

The following documents and revision level are applicable and form an integral part of this document to the extent specified herein.

TABLE 3 – APPLICABLE DOCUMENTS

AD #	Document Number	Title	Revision
AD-01	STDP Contract iFTS EBB ABBCABOM-08573	imaging Fourier Transform Spectrometer Elegant Breadboard Executive Report	Version A

2.2 REFERENCE DOCUMENTS

The following documents and revision level are for reference only. They provide additional information or guidelines that either may clarify the contents or are pertinent to the history of this document. If needed, they will be shared with the selected contractor to carry out the work during the contract.

TABLE 4 – REFERENCE DOCUMENTS

RD #	Document Number	Title	Revision
RD-01	BSO-MU-0-4793-CN	User Manual for CNES Zero Pressure Balloons French English	Version 3.0
RD-02	CSA-iFTS-CAD-00036	Gondola CAD Model	Version A

2.3 DOCUMENT DELIVERABLES

The Contractor shall prepare and deliver the documents as requested in the Table 6.

2.3.1 Document Deliverables, Format and Content

The Contractor shall ensure that documents delivered comply with the general preparation instructions and applicable Data Item Descriptions (DID) as found in Appendix A.

Alternatives to the DIDs document format, its content and its submission methods are acceptable to the CSA. However, the alternative Contractor format shall meet the intent of the stated DID.

Documents shall be delivered in the original software application format, plus in Portable Document Format (PDF). One electronic copy of each deliverable document shall be transferred

to the CSA at the address and in the format specified in DID-0001. No paper copy is to be delivered, except when requested by the Technical Authority (TA).

2.3.2 Deliverables and Contractual Data Requirements List (CDRL)

TABLE 5 – LEGEND

A	**Approval needed**
CF	**Contractor Format**
F	**Final**
IR	**Initial Release**
U	**Updated**
R	**Review by CSA**

TABLE 6 – CONTRACT DATA REQUIREMENTS LIST (CDRL)

CDRL No.	Deliverable	M/S	DUE DATE (working days)		Approval Category	Format
			Definition	Implementation		
01	Project Management Plan		CA + 30 (F)		A	DID-0002 DID-0015
02	iFTS Requirements Document	M2	CA + 20 (F)		R	DID-0009
03	DDR Documentation	M2	DDR-10 (F)		R	DID-0008
04	Instrument Simulator Development Plan	M3		CA + 80 (F)	A	CF
05	Retrieval Development Documentation	M3		DDR + 40 (IR) TRR -10 (F) (M3)	R	DID-0008
06	Instrument Calibration and Test Plan	M3		DDR + 100 (F)	A	DID-0011
07	Instrument Simulator Report	M3		TRR - 10 (F)	A	DID-0010
08	Retrieval Algorithm	M3		TRR -10 (F)	R	CF
09	TRR Documentation	M3		TRR -10 (F)	R	DID-0011 DID-0008

CDRL No.	Deliverable	M/S	DUE DATE (working days)		Approval Category	Format
			Definition	Implementation		
10	Instrument Calibration and Test Report	M4		PSR - 10 (F)	A	CF DID-0012
11	Gondola Integration and Instrument Check-Out Plan	M4		PSR-10 (F)	A	DID-0013
12	PSR Documentation	M4		PSR-10 (F)	R	DID-0008
13	FRR Documentation	M5		FRR-10 (F)	R	DID-0008
14	iFTS Balloon Demonstration (Support during and post flight)	M6		FRR +5	A	CF
15	Data Analysis and Validation Documentation	M7		FRR+200 (IR) FRR+220 (F)	A	CF
16	Close Out Activities (Disclosure of Intellectual Property, Final Report and Presentation, Asset Declaration Form – Prototypes and Equipment)	M8		FRR+ 240 (IR) FRR + 260 (F)	A	DID-0005 DID-0012 DID-0014 DID-0015

2.4 DOCUMENTS APPROVAL

The TA will provide approval or disapproval within ten (10) working days of receiving the document. In the event that a document is disapproved, the TA will advise the Contractor in writing, as to the reasons for such disapproval. Such notification will include a full explanation of the reasons for the lack of approval and will direct the additions, deletions and/or corrections, which the TA deems are required for approval. With this notification, the TA will provide the allowable delay for re-submission.

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3 BACKGROUND INFORMATION ON THE GONDOLA

This section provides background information for the interfaces and environment associated with the azimuthally controlled gondola. Specifically, this section includes introductions and implications associated with the gondola interfaces (mechanical, electrical, communication, etc.) and the anticipated thermal-vacuum environment at stratospheric altitudes.

The host gondola baselined for the stratospheric balloon demonstration is described in the CAD file [RD-02] and the user manual [RD-01]. This host gondola is commonly referred to as the gondola in this statement of work.

3.1 MECHANICAL INTERFACES AND REQUIREMENTS

The gondola is a CNES operated azimuthally controlled gondola. It is depicted in Figure 1 below.

3.1.1 Gondola Floor

Heavy and large payloads can be integrated on the gondola floor. The floor consists of five (5) aluminum panels attached to two rails to provide a modular concept. Each panel can be removed in order to save mass or provide a 242 mm x 350 mm nadir view through the gondola floor tubing. Their position can also be shifted on the rails by a 100 mm increment (see Figure 1 to Figure 5). The panels provided a bolting interface using M6 threaded inserts. The payloads should be fixed using M6 screws of minimum quality A4-70 (Yield> 450 MPa; Limit break> 700 MPa). The tightening torque applied for tightening the M6 screws must be 7 Nm.

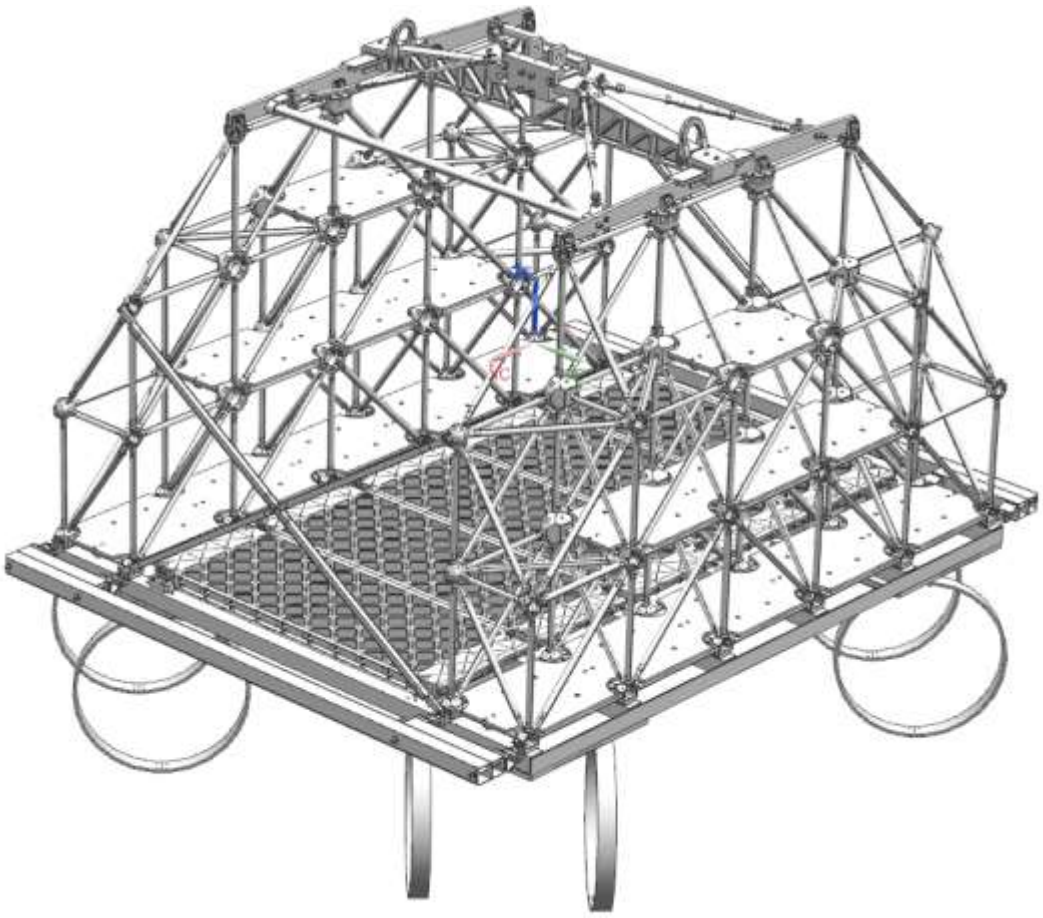
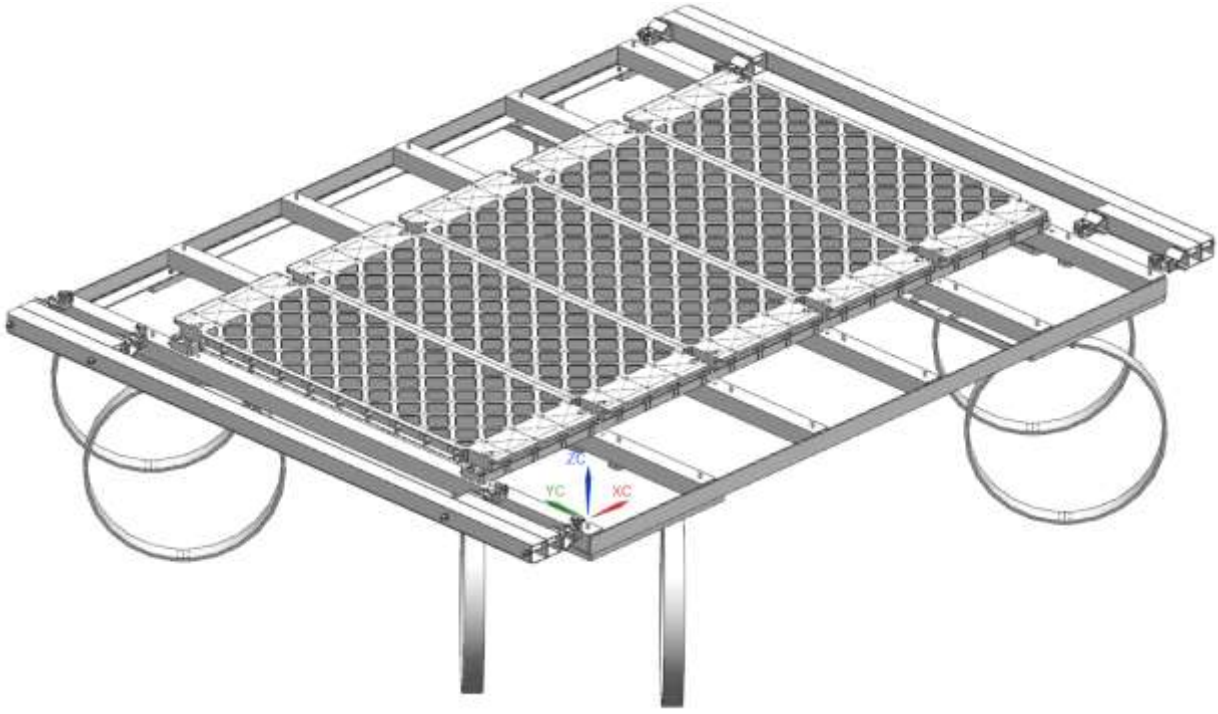


FIGURE 1 GENERIC GONDOLA STRUCTURE



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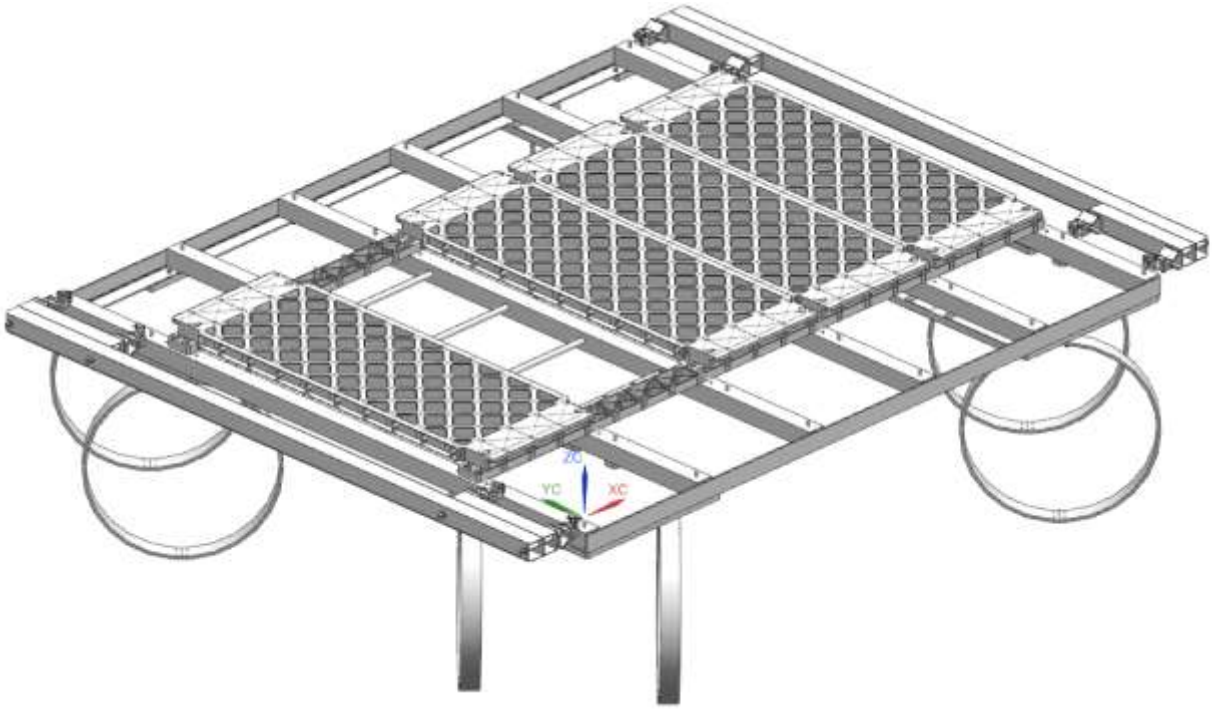

B

FIGURE 2 GONDOLA FLOOR MODULAR CONFIGURATION (ISO VIEW)

(WALL AND TOP STRUCTURE HIDDEN FOR CLARITY A) FULL FLOOR CONFIGURATION B) MODULAR CONFIGURATION

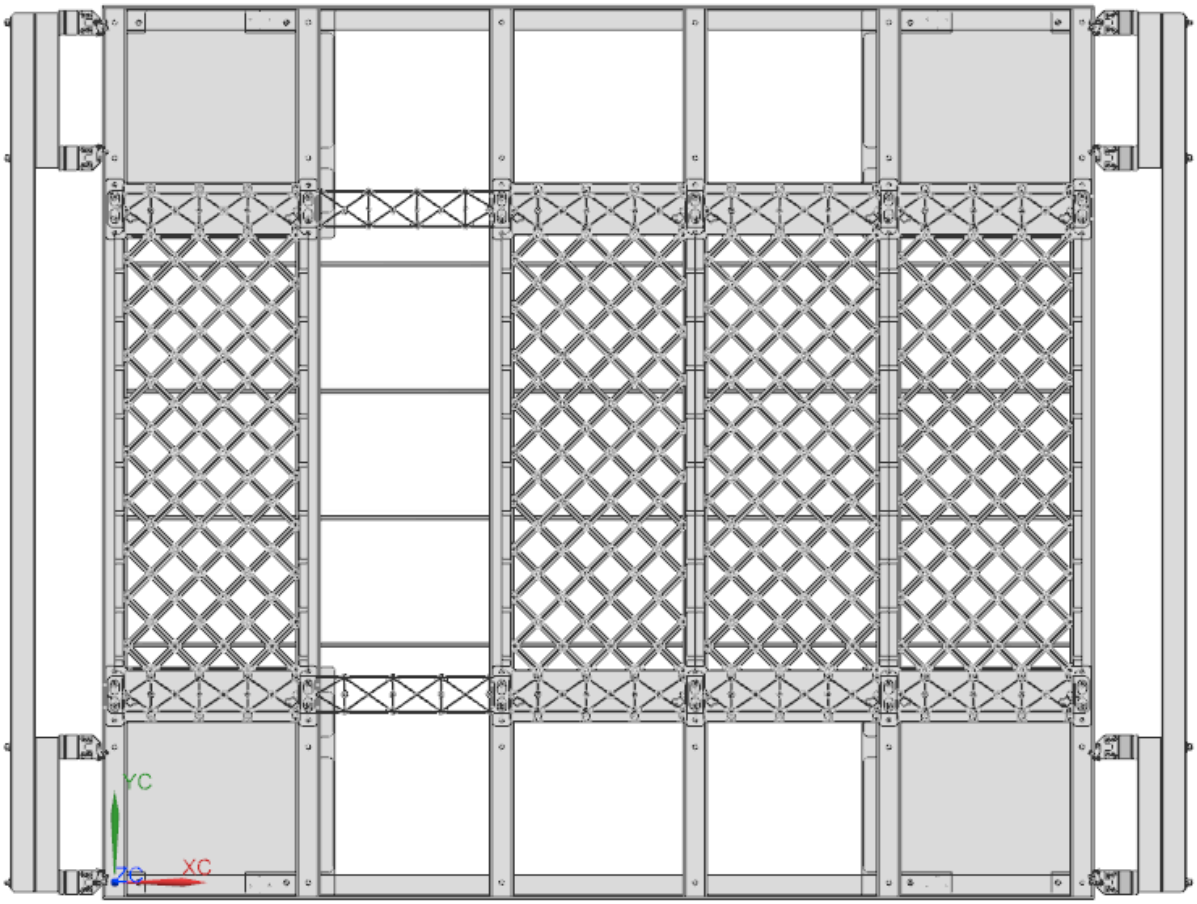

FIGURE 3 GONDOLA FLOOR MODULAR CONFIGURATION (TOP VIEW)

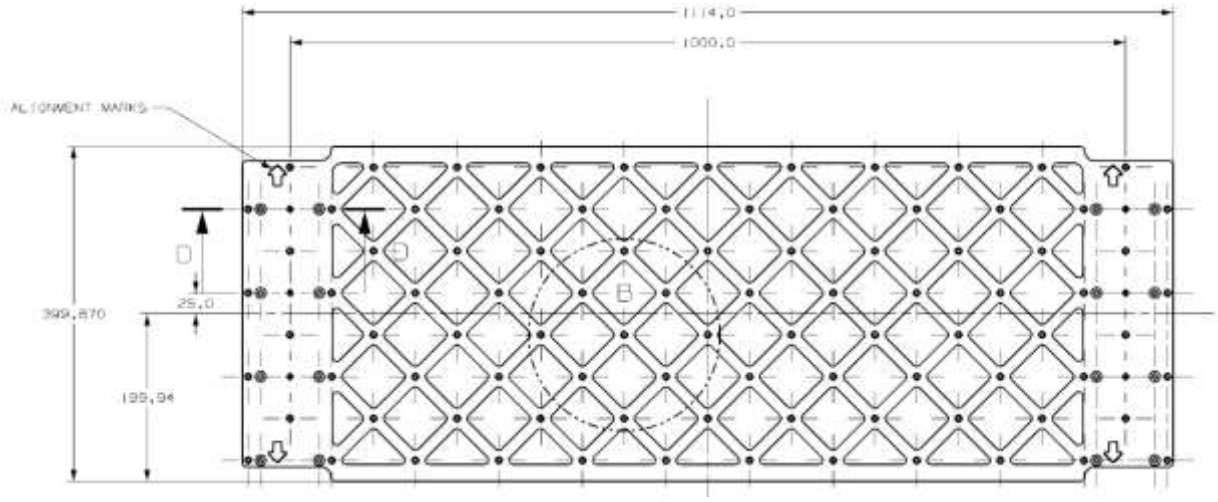

FIGURE 4 GONDOLA FLOOR SINGLE PANEL (TOP VIEW)

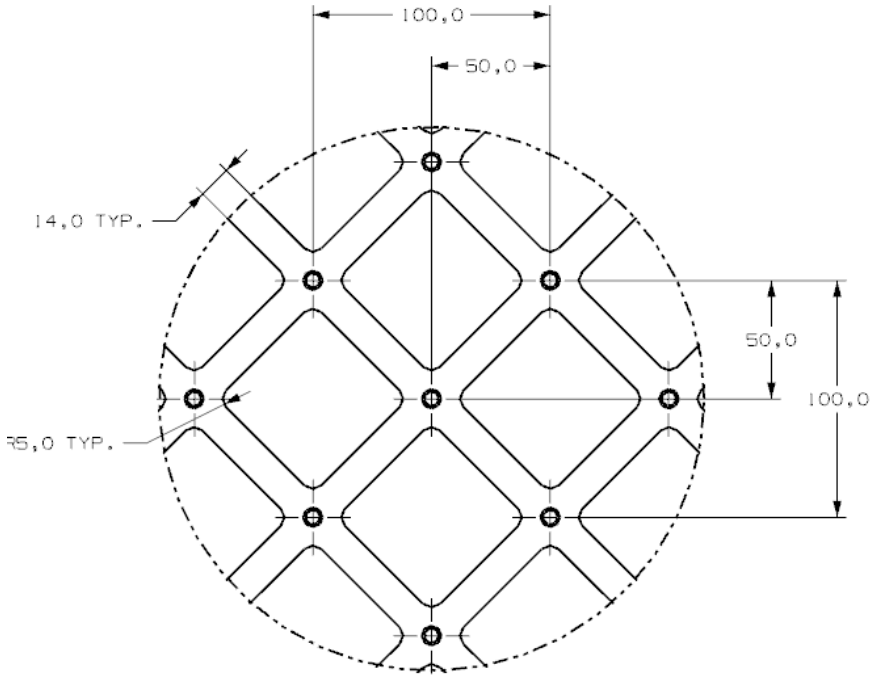

FIGURE 5 GONDOLA FLOOR SINGLE PANEL BOLT PATTERN

The maximum mass, M, of equipment that can be installed on each panel is 50 kg and the Center of Gravity (CG) shall be 30 cm above the panel maximum.

3.1.2 Gondola Walls

Additionally, equipment can be installed into the walls of the gondola. This is currently the intended location for installation of the small remote Electronics Unit. A wall cell is depicted in Figure 6. The maximum authorized mass of equipment in a cell of the wall structure is 22 kg (including clamping mechanisms).

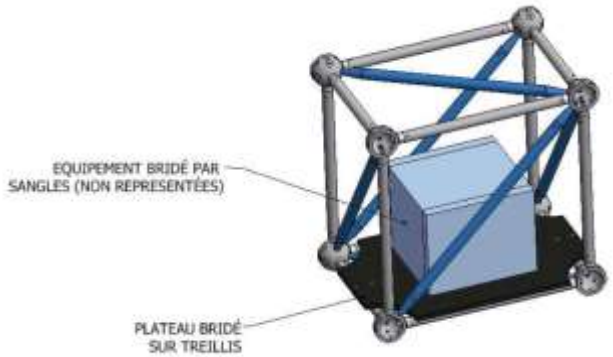

FIGURE 6 GONDOLA WALL CELL

The available volume in a wall cell for a device is 342 x 342 x 222 mm^3, seen in the diagram below (Figure 7).

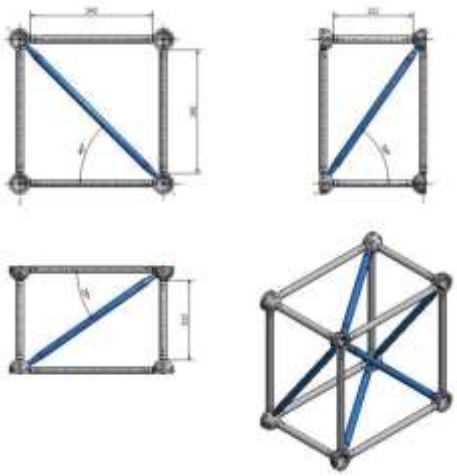

FIGURE 7 VOLUME OF GONDOLA WALL CELL

The worst case acceleration experienced by the gondola and integrated payloads happens during separation prior to landing. The loading experienced by the payload gondola at this time depends on the payload gondola mass, the mass of the avionic gondola [Nacelle de Servitude Opérationnelle – NSO] and the stiffness of the links between the gondolas [RD01]. For design purposes, in the absence of definitive information on gondola mass (at present), the survival of all attachment points shall be demonstrated using combined 10 g vertical load, and 5 g transverse loads. Simple coupled analysis shall be performed where the effective bolt preloads are reduced by the vertical load prior to investigating the safety margin due to the transverse load. All safety margins shall be positive with a factor of safety of 2.

During transport at the launch site and transport from the recovery site, the payload gondola and its elements shall withstand vibration forces of 3.85 g rms without breaking apart or separating, which corresponds to the acceleration spectral density indicated below.

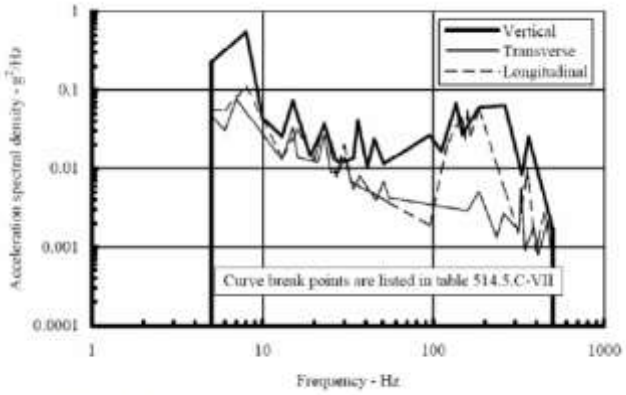

FIGURE 8 ACCELERATION SPECTRAL DENSITY OF VIBRATION FORCES DURING TRANSPORT AND RECOVERY

3.2 ELECTRICAL INTERFACES

The current assumption is that the power distribution of the gondola is identical to the services offered on the 2014 Nimbus-7 flight for the SHOW instrument. During that campaign the CSA generated an electrical and communications Interface Control Document (ICD) [RD01]. In this document, power distribution is defined through the MDE (power distribution module). Please note that discussions regarding the SIREN module for communications are no longer relevant as SIREN has been recently replaced by PASTIS (discussed below). The interface regarding the MDE is reproduced below, but requires confirmation on its applicability from the CSA.

For payloads requiring external supply, an unregulated 28V +/- 2V (TBC) bus is made available by the MDE. Figure 9 shows the MDE's connector plane. The module has a total of twenty switched outputs: five are limited to 8A and fifteen are limited to 5A. Payloads requiring more than 8A can use more than one service line depending on availability. Each power output can be switched on and off individually, but it should be noted that synchronized switching is not possible.

Table 7 lists the available power services, type of connector and associated pinout. Mating connectors to be installed on the cables that connect to the MDE are as follows:

MIL-DTL-26482 Series 1 Mating connectors

8A: MS3116F12-3P or
Souriau 851-06EC123P50 or
Amphenol PT06E-12-3P(SR) or
ITT Cannon KPT06F123P

5A: MS3116F8-3P or
Souriau 851-06EC83P50 or
Amphenol PT06E-8-3P(SR) or
ITT Cannon KPT06F83P

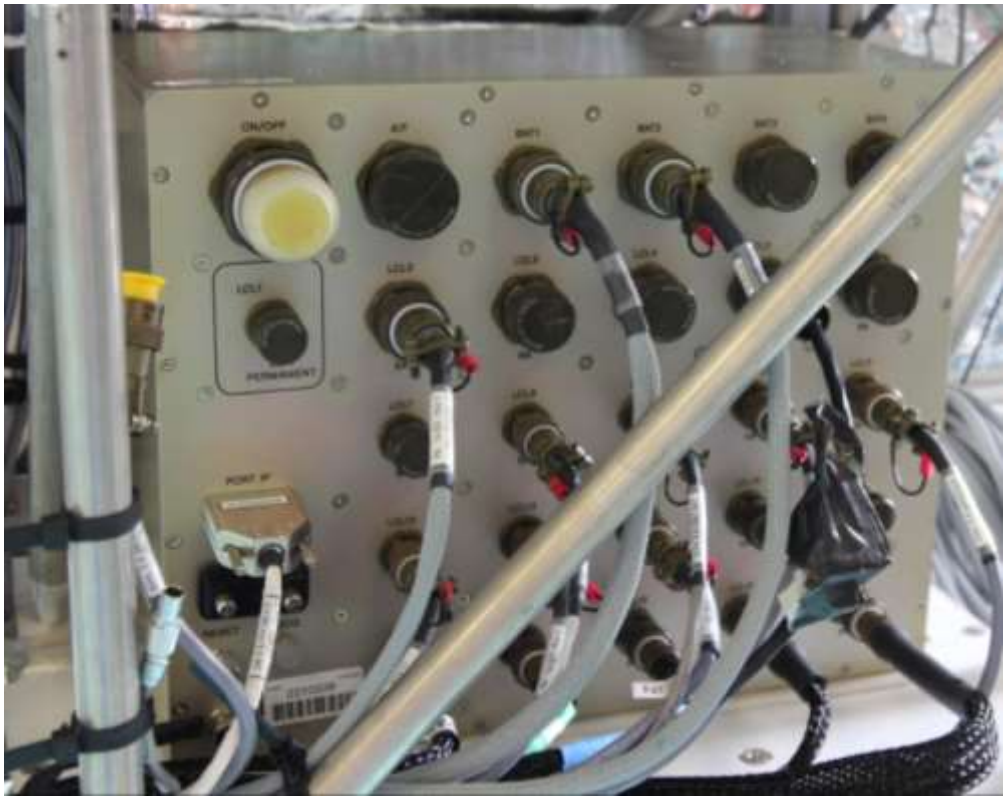

FIGURE 9 POWER DISTRIBUTION UNIT MODULE

TABLE 7 – POWER INTERFACE

Fused Current	Power Service Tag	Connector			
		Manufacturer	Part Number	Pinout	
5A	LCL1, LCL7 to LCL21	Souriau	851-07A83S5016	 Female	Pin A : Power- Pin B : NC Pin C : Power+
8A	LCL2 to LCL6	Souriau	851-07A123S5016	 Female	Pin A : Power- Pin B : NC Pin C : Power+

3.3 COMMUNICATION INTERFACES

Payloads aboard the gondola can communicate with the ground using CNES' communication sub-system called PASTIS. During flight, this module essentially constitutes a transparent bridge for telemetry and command to be transferred through the aerostat network (NOSYCA) between a payload and a mission PC on ground (Figure 10).

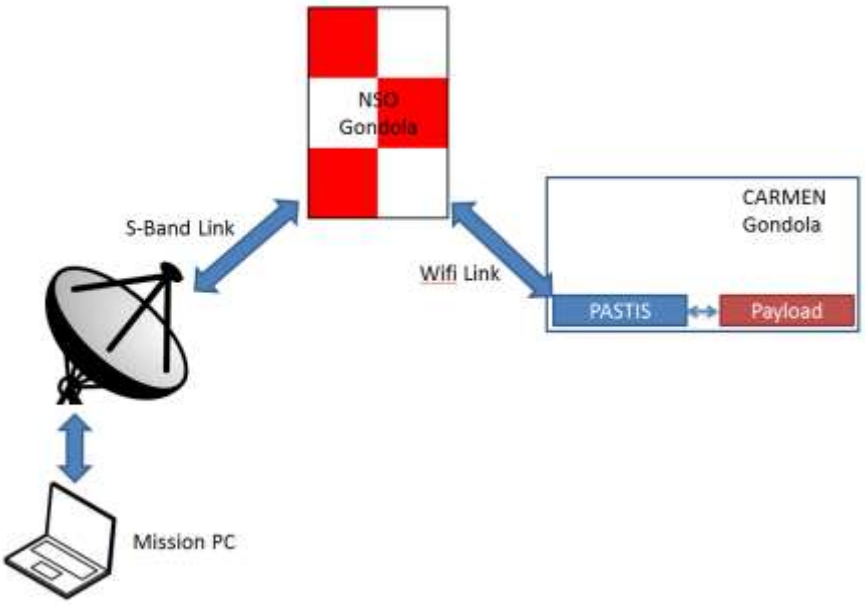

FIGURE 10 COMMUNICATIONS LINK

PASTIS supports two communication protocols: Ethernet IP or Serial (RS 232/422/485). Moreover, the module also includes Open-Drain commands, allowing remote switching of payloads.

To reduce mass when the serial interface is not used during a mission, PASTIS has been split into two modules: PASTIS PRINCIPAL and PASTIS AUXILIAIRE. The former has Ethernet and Open-Drain functionality, while the latter has Ethernet and Serial functionality.

As can be seen in the pictures (Figure 11), interfacing to any Ethernet, Serial and Open-Drain (TOR) service is done using DE-9 (DB9) connectors.

PASTIS has its counterpart on ground, usually located in the Scientists' Mission Control Room. This ground segment PASTIS interfaces to the mission PCs through either standard RJ45 sockets for Ethernet or DE-9 connectors for serial.

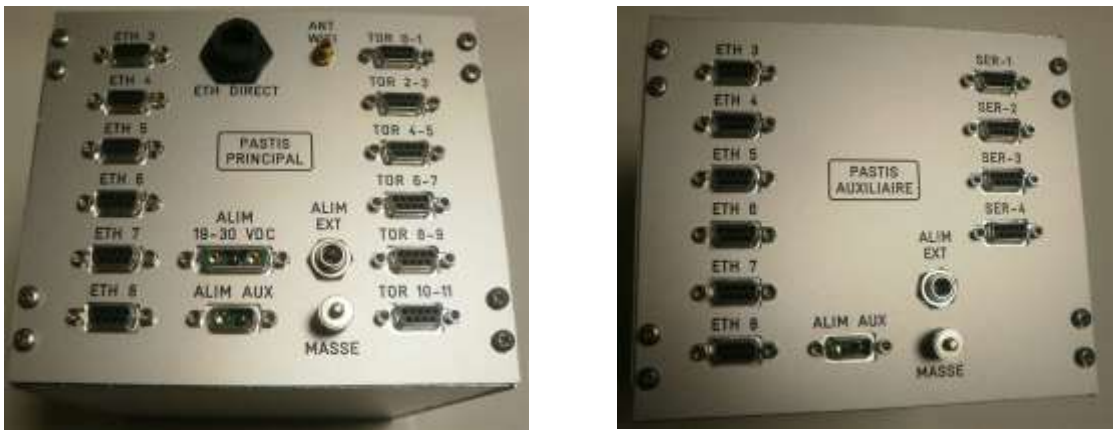

FIGURE 11 PASTIS

3.4 THERMAL VACUUM ENVIRONMENT

Atmospheric pressure diminishes by approximately a factor of 10 with every 16 km increase in altitude. Atmospheric pressure is 100 hPa at altitude 16 km, 25 hPa at 25 km, 10 hPa at 31 km and 2 hPa at 42 km. Pressure is usually used by balloonists as a vertical coordinate.

The air temperature in the troposphere decreases on average by 6.5°C every 1 km. The rate of decrease can be altered, however, when a wintertime temperature inversion occurs in the interior of a continent, where the ground surface cools because it receives very little solar energy. In the stratosphere (from the tropopause to about 50 km), the temperature of the air increases with altitude due to absorption of solar radiation by ozone. A typical depiction of temperature as a function of altitude and pressure is seen in Figure 12.

The tropopause is defined as the upper limit of the troposphere. Its altitude varies according to the season and geographical area (from 8 km at the poles to 18 km at the equator, approximately). It is also affected by atmospheric phenomena in the troposphere.

The extremes of air temperature that could be encountered by flights launched from Timmins, Ontario, are depicted in Figure 13. These temperature values are the product of ECMWF re-analyses (ERA-Interim) data from 1 April to 31 October of the years 1990 to 2010, for longitudes from 60°W to 120°W, latitudes from 40°N to 60°N, and horizontal resolution of 0.5° and 1°. The average air temperature is very close to the ISA profile, while the extrema show an average spread of about 18°C and a maximum spread of about 40°C for the minimum temperature at 2 hPa.

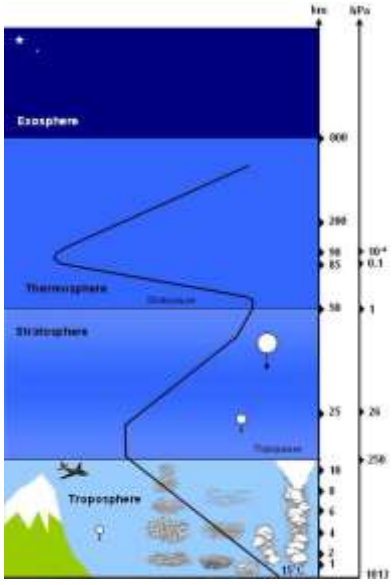

FIGURE 12 DEPICTION OF THE VARIATION OF TEMPERATURE AS A FUNCTION OF ALTITUDE AND PRESSURE.

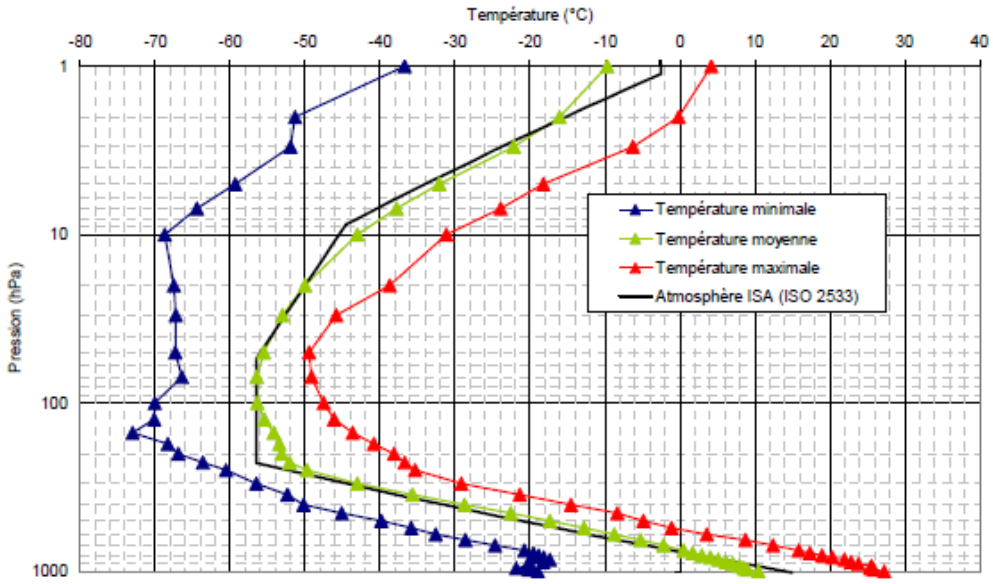

FIGURE 13 AIR TEMPERATURES FROM ECMWF RE-ANALYSES OF ERA-INTERIM DATA FROM APRIL 1 TO OCTOBER 31 OVER 20 YEARS FOR LONGITUDES 60°W TO 120°W AND LATITUDES 40°N TO 60°N.

For constant ceiling flights, we anticipate a float altitude in the range of 30 – 40 km, corresponding to an approximate pressure range of 2-10 hPa. The operating temperature range over these altitudes, on average, is -45 ^{o}C to -15 ^{o}C. At worst case, the temperature range is -70 ^{o}C to +0 ^{o}C.

Of particular interest is the seasonal variation of air temperature. This is seen in Figure 14 for the relevant temperate zone. Considering the late-summer/fall flight planned for iFTS the relevant temperature ranges for 2-10 hPa are -80 ^{o}C (cold-case Autumn @ 10 hPa) to 0 ^{o}C (warm case summer @ 2hPa).

The worst case temperatures seen while passing through the tropopause are on the order of -90 ^{o}C to -70 ^{o}C, while ground temperatures can vary significantly.

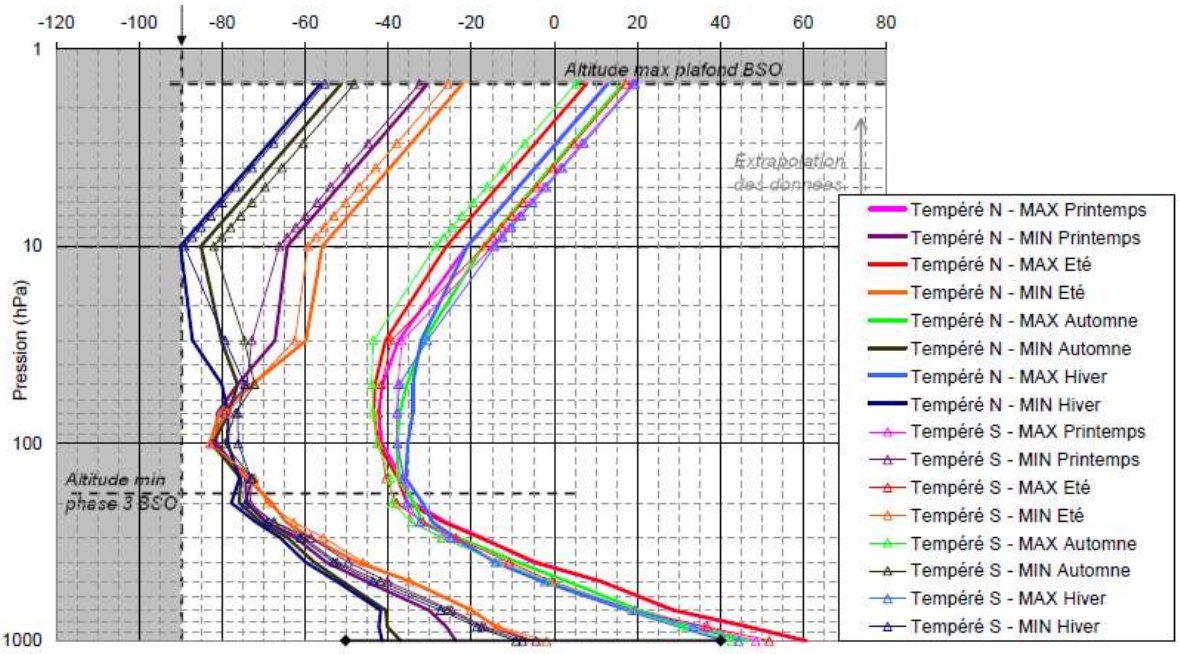

FIGURE 14 SEASONAL VARIATION OF AIR TEMPERATURE WITH ALTITUDE FOR TEMPERATE ZONE.

It should be noted that the air temperatures may not be exactly that experienced by the iFTS instrument and will depend on the configuration of the gondola during flight. The gondola can be equipped with external thermal covers to confine heat within the nacelle. The cover consists of an assembly Thermolite MICRO 150 g / m² sandwiched between a tissue black polyamide (inner faces) and a white fabric polyamide (outer faces). The thickness of the whole of this protection is approximately 1.7 cm.

In addition to thermal protection, thermo-reflective screens to avoid direct illumination can be attached on the cover to limit the temperature increase inside the nacelle for day flights (especially when the platform edges in a given direction). In some cases, responding to the scientific missions, it is necessary to perforate the cover to allow a target to the outside of the nacelle. This is made possible by the removal of some panels of the cover. The cover can be opened over the entire height of the nacelle opposite front and rear. Representative examples of the thermal covers are seen in Figure 15. It is anticipated that a similar configuration will be required for the iFTS instrument.

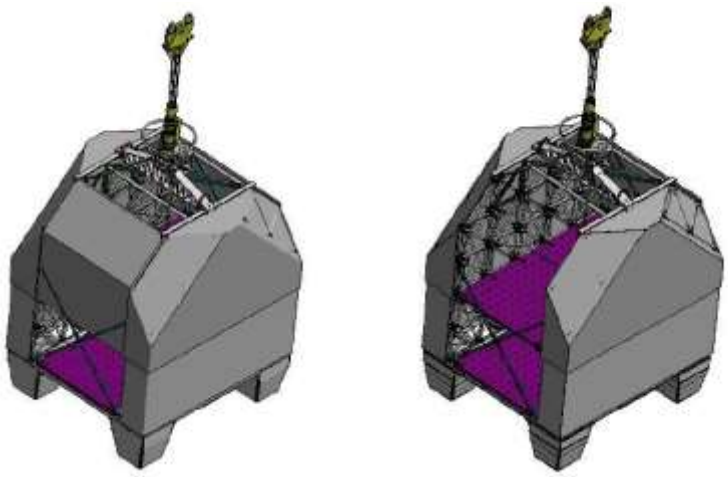

FIGURE 15 DEPICTION OF THERMAL COVERS ON THE GONDOLA

4 WORK PACKAGES

The following sections describe the Work requirements that shall be accomplished by the Contractor.

4.1 SCIENCE

The contractor shall establish calibration and validation activities related to the iFTS instrument adaptation for the stratospheric balloon launch.

The work to be performed by the Contractor can be divided into the following major Work Packages (WPs):

- WP 1: Requirements Development
- WP 2: Instrument Simulator Development
- WP 3: Retrieval Development
- WP 4: Instrument Calibration
- WP 5: Flight Operations and Post Flight Check-out/Calibration
- WP 6: Data Analysis and Validation

Descriptions of the WPs appear below. Note that there is no obligation for the Contractor's bid to retain this structure for the formal Work Package descriptions.

4.1.1 WP1: Requirements Development

The contractor shall support the establishment of the mission, science, and flight requirements for the stratospheric balloon demonstration of the iFTS instrument. This shall include a review of the system and sub-system requirements produced during a complementary industrial activity [AD-01] which is focused on the development of the iFTS instrument and the adaptations required by the interfaces associated with the gondola [RD-01]. Where appropriate, this shall include recommendations to refine or clarify requirements, as well as the identification of missing requirements. Of particular interest will be all requirements related to functionality, telemetry, and command which shall be consistent with the envisioned concept of operations.

In addition, the Contractor (Flight Mission Team) shall develop and document requirements related to the functionality of the Ground User Interface that will be necessary for instrument operations both during test activities and the flight campaign.

This work package shall also include the development and documentation of viewing geometry requirements (i.e. altitude, view angle, duration) applicable for flight on the stratospheric balloon, as well as a determination and documentation of tolerances balloon altitude and orientation.

Phase	Deliverables	Milestone	Format
Definition	iFTS Requirements Document	M2	DID-0008 DID-0009

4.1.2 WP2: Instrument Simulator Development

The contractor shall apply a simple FTS simulator to support requirement validation and retrieval development. This can be carried out in collaboration with ECCC who could share previous simulators with the Contractor. This simulator shall account for the as-built optical performance of the instrument (e.g. PSF and iFOV), straylight estimation and correction approaches, calibration data, viewing geometry, atmospheric conditions, and retrieval algorithms to connect the instrument performance specifications to the 1D profile of the relevant atmospheric species. The purpose here is to be able to estimate signal-to-noise ratios (SNR), impact of straylight, and achievable spatial resolution, as well as to provide a computational tool to refine the algorithms and calibration procedures defined in Work Packages 3 and 6.

This work package shall include a report detailing the specifics of the simulator, providing sample 1D profiles, and computational tests to explore the expected instrument performance with respect to SNR and straylight on the quality of the final data products.

WP2 is intended to model:

0a) raw interferograms
0b) corrected interferograms
1a) spectra
1b) corrected spectra
2) column averaged mole fractions

Where necessary, values can be assumed but shall be updated with measured values from calibration and test activities from later project phases.

The WP shall minimally include the following:

a) Ensure consistency with the defined concept of operations
   - Integration time
   - Dull image/ spectral acquisition time
   - Nominal/notional radiance
   - Balloon geometry (notional altitude and motion)

b) Instrument parameters
   - Point Spread Function
   - Transmission (per optical component, spectral behaviour)
   - Spectral Sampling
   - Instrument line shape
   - Dark current
   - Noise
   - Sensor Performance

It is noted that the input from the industrial team developing the iFTS instrument adaptation for the stratospheric balloon demonstration will be required.

c) Identification of calibration needs
d) Predicted raw interferogram (level 0)
e) Predicted calibrated interferogram (level 1a)
f) Predicted calibrated spectrum (Level 1b)

Support from ECCC radiative transfer specialists is to be expected.

Phase	Deliverables	Milestone	Format
Definition	• Instrument Simulator Development Plan • Instrument Simulator Report	M3 M3	CF DID-0010 DID-0008

4.1.3 WP3: Data Product Retrieval Development

The WP3 shall develop the data product retrieval approach for the iFTS instrument. The retrieval development shall minimally include the following:

a) Comparison of results with AIM-North observational requirements – including an assessment of performance for precision and bias.
b) Validate/refine the calibration needs/approach identified in the simulator work package to achieve Level 1b spectra.

Support from ECCC retrieval specialists is to be expected.

Phase	Deliverables	Milestone	Format
Definition	• DDR Documentation • Retrieval Development Documentation • Retrieval Algorithm	M2 M3 M3	CF DID -0008

4.1.4 WP4: Instrument Calibration and Test

The Contractor shall define, perform, and document detailed calibration activities to enable post-processing of the iFTS data acquired during the flight campaign.

The current scope includes detailed calibration activities where, in addition to instrument performance assessment, the purpose is to integrate the calibration data into the post-flight data product processing stream. Minimally, the spectral resolution, spectral range, FOV, imaging performance, and responsivity (including flat fielding, non-uniformity corrections, and identification of saturation limits) shall be characterized through optical calibration once the

instrument is fully assembled, passes verification tests, and is delivered from the Instrument Provider associated with the concurrent activity [RD-01].

These calibration activities shall minimally be performed in an ambient laboratory environment, and should be performed in a representative thermal-vacuum environment defined by the anticipated altitude of the flight as there may be thermal and heat dissipation effects associated with camera responsivity, as well as thermo-elastic deformations affecting imaging performance. For detector responsivity (flat-fielding, non-uniformity corrections, and saturation), the calibration tests shall include a variety of detector settings (gain, and integration time as appropriate) representative of the anticipated radiometric environment and acquisition scenario of the flight.

This Work Package shall also include the development and procurement of any necessary operator interface, Ground Support Equipment (GSE), the delivery of a detailed Calibration and Test Plan, which discusses the procedures, set-ups, and related analysis, as well as the delivery of the associated Calibration Report. Further, both pre- and post-flight calibrations shall be acquired to assess any instrument changes during the flight.

Phase	Deliverables	Milestone	Format
Implementation	• Instrument Calibration and Test Plan • Instrument Calibration and Test report	M3 M4	 CF DID-0011 DID-0012

4.1.5 WP5: Flight Operations and Post Flight Instrument Check Out/Calibration

This Work Package shall include leading instrument operations and data acquisition during the flight campaign in Timmins, Ontario. The estimated duration of the flight campaign is two weeks.

This Work Package shall provide science support for the flight requirements, and the planning of the flight profile including duration, launch time, and measurement windows. This shall also include the delivery of any documentation required by CSA/CNES to define the associated flight requirements and profile.

The Contractor shall lead the instrument integration on the gondola. This includes interface verifications, including on-site rapid data processing required for pre- and post-flight tests. Integration of the iFTS instrument onto the gondola, and verification of the associated mechanical, electric, and communication interfaces will be performed with support from CSA/CNES staff.

Furthermore, the Contractor shall perform a post-flight instrument check-out including cleaning and assessments of operability. In the event that the instrument remains operable, the Contractor shall perform post-flight calibration activities to investigate responsivity at the acquisition settings used during the flight campaign and to assess if any degradation in performance has occurred.

The contractor shall pack the iFTS instrument for delivery to Timmins and repack it for the return to the contractor's site. Finally, the contractor shall pack the instrument for delivery to the CSA at the end of the contract. The CSA will assume the shipping costs.

Phase	• Deliverables	Milestone	Format
Implementation	• Gondola Integration and Instrument Check-Out Plan • PSR Documentation	M4 M4	DID-0013 DID-0008
	• FRR Documentation	M5	DID-0008
	• Support during flight • Support post flight	M6 M6	CF

4.1.6 WP6: Data Analysis and Validation

This Work Package shall provide the adaptation and development of the iFTS data product retrieval scheme to the balloon flight and instrument conditions. This shall include level 0 to 1 data processing incorporating the acquired calibration data. In addition, this shall include level 1 to 2 data processing to provide quantitative trace gas abundance. Data acquired during the flight campaign shall be processed to demonstrate quality for the desired trace gas abundance data.

Documentation shall be produced. This shall include descriptions of the algorithm/processing chain, flight configuration, detailed flight timeline, instrument telemetry (e.g. power consumption, external and internal temperatures during ascent/descent and flight), samples of measured spectra, retrieved profiles, and the assessment of instrument performance including comparison with modelled spectra and any available coincident measurements (near coincident overpasses from satellite instruments with appropriate measurement capability). Recommendations for future work and potential instrument or algorithm improvements shall be included in the documentation as derived from any concerns with instrument performance, modelling capability, and retrieval algorithm fidelity. The focus of the recommendations will be on a future space flight mission of the iFTS instrument.

Phase	• Deliverables	Milestone	Format
Implementation	• Data Analysis and Validation Documentation	M7	CF
	• Disclosure of Intellectual Property • Final Report and Presentation • Asset Declaration Form – Prototypes and Equipment	M8 M8 M8	DID-0005 DID-0012 DID-0014 DID-0015

4.2 PROJECT MANAGEMENT

4.2.1 Project Management Plan (PMP)

The Contractor shall provide and implement the Project Management Plan as per DID-0002, or an equivalent Contractor format document.

The Project Management Plan is used to guide both project execution and project control. The PMP is used by the Government to assess the adequacy of the Contractor's plan for management of the work and to provide a basis on which to monitor and assess the progress of the work.

The PMP is used to:

- Guide the project execution;
- Document project planning assumptions;
- Document project planning decisions regarding alternatives chosen;
- Facilitate communications amongst stakeholders;
- Define key management reviews as to content, extent and timing; and
- Provide a baseline for progress measurement and project control.

4.2.1.1 Work Breakdown Structure (WBS) and Description

The work shall be planned, controlled and directed according to the Work Breakdown Structure (WBS) and associated WBS Dictionary to be provided with the proposal as per DID-0002. The WBS Dictionary defines the work to be done against each WBS element identified in the WBS, by means of a Work Package Description (WPD) for each such element.

4.2.1.2 Project Schedule

The Contractor shall track and update a schedule that shows dependencies between tasks, durations, % complete, critical path, long lead items (if applicable) and constraints. The Contractor shall maintain and deliver the Project Schedule based on the WBS, at review meetings.

As governed by preferences of the contractor, or variations in the contract award date, an alternative schedule can be proposed, but shall respect the following constraints:

- Balloon flight from Timmins, Ontario in the August-September 2022 timeframe.
- Work Authorization Meeting (WAM) (i.e. Go/No-Go) shall be held at the Detailed Design Review (DDR), Test Readiness Review (TRR), Pre-shipment Review (PSR), and Flight Readiness Review (FRR).
- The delivery of the instrument and associated deliverables of M4 (Pre-Shipment Review meeting) shall be 5 weeks minimum before the Stratos Campaign.
- The Final Review meeting should occur following the flight campaign so that the contractor can be debriefed by the iFTS mission team.

4.2.1.3 Cost Estimate

The Contractor shall evaluate cost projections according to DID-0002. All assumptions used to create the estimate shall be listed. Any options or de-scope options that are included shall be clearly described.

4.2.1.4 Project Management Control and Progress Reporting

The Contractor shall conduct monthly project status meetings with the CSA, to review the project status and to resolve unforeseen and urgent issues. The selection of participants will depend on the nature of the issue. These meetings will be held by teleconference. The only deliverables for these progress meetings are the Action Items Log (DID-0006) and the Monthly Progress Report (DID-0007) to be delivered as support material by the contractor one business day before the meeting.

Note that baseline for project status meetings is monthly but CSA reserves the right to increase the frequency to biweekly if required.

4.2.1.5 Risk Management

The Contractor shall identify and monitor areas of cost, schedule, programmatic and technical risk and shall identify and implement appropriate risk responses, such as risk transfer, mitigation activities, or acceptance.

4.2.1.6 Intellectual Property (IP)

The Contractor shall explicitly define the Foreground Intellectual Property (FIP) generated during the execution of the contract and report this in the IP Disclosure Report (DID-0015). This document shall also identify the Background Intellectual Property (BIP) that is required to use the FIP. The BIP disclosure provided with the proposal shall be updated if applicable.

4.2.1.7 Prototypes and Equipment

All prototypes developed during the Contract shall be disclosed to Canada and reviewed by the PA who will advise on their final disposal and /or delivery.

The Contractor should also maintain a list of all non-consumable items procured or fabricated under the contract and/or provided by the government. The Contractor shall complete and submit the Asset Declaration Form found in APPENDIX B. The Contractor will be notified as to how the assets (equipment) should be handled after the PA and TA have reviewed the list.

4.2.1.8 Software

The Contractor shall provide an electronic copy of all Contractor documents describing the software development cycle, including user, maintenance and operation manuals. The developed software shall also be provided in the form of well-documented source code in computer compatible format, with run-time libraries and executable files.

4.2.2 Meetings

The Contractor will schedule and co-ordinate meetings with all the stakeholders. For all meetings, the Contractor will:

- Suggest the meeting content and deliver the suggested meeting agenda to the PA and the TA at least ten working days before the meeting;
- Deliver to the PA and the TA, all required reports and technical documents relating to the work about which the meeting is about at least 5 days before the meeting;
- Record the minutes of the meeting; and
- Deliver one (1) electronic copy of the minutes of the meeting to the PA five working days after the meeting.

In support of the project meetings, supporting presentation materials should be prepared.

The contractor shall provide a Meeting Agenda (DID-0003) for all reviews and meetings including and shall deliver these to the CSA TA and/or CSA PA no less than 5 business days before the meeting and shall have it approved by the CSA TA and/or CSA PA.

The Contractor shall produce the minutes for all reviews and meetings including teleconferences and shall deliver these to CSA. In the case of teleconferences, they shall be delivered within 5 business day.

The Contractor shall maintain a detailed Action Items Log (DID-0006) throughout the project to track actions resulting from all reviews and meetings including teleconferences.

The Contractor may request ad-hoc Meetings with CSA whenever required to resolve unforeseen and urgent issues. The CSA may also request such Ad-hoc Meetings with the Contractor. The selection of participants will depend on the nature of the issue.

The PA and the TA reserve the right to invite additional knowledgeable people (Public Servants or others under Non-disclosure Agreement) to Review Meetings. Key Contractor personnel involved in the work under review should attend the Review Meetings. The exact location, date and time of Review Meetings are to be mutually agreeable to the PA and the Contractor.

4.2.2.1 Kick Off Meeting

Within two weeks of the contract award (or at a date mutually agreeable to by the PA and the Contractor) a Kick-Off Meeting (KOM) shall be held to present the Contractor's plan for carrying out the project and to address all significant issues. Refer to DID-0004 for preparation instructions.

4.2.2.2 Milestone Review Meetings

Milestone Review Meetings will be held periodically throughout the life of a Contract to provide formal opportunities for face-to-face or teleconference information exchanges as well as for progress monitoring discussions and decision making. A Milestone Review Meeting will be held at the end-point of each milestone. Table 1 shows the meetings schedule and location. It is also noted that many meetings will be held by teleconference. The DDR will be held simultaneously with the iFTS advancement for balloon flight contract and led by the industrial contractor. Review Meetings relevant to the present SOW aim at sharing information and validate project alignment. The level of effort associated with these reviews will correspond to the basic objectives of a capability demonstration project that will operate for a maximum of two days. The review presentation package information for specific milestone review meetings can be found in DID-0008. Refer to DID-0005 for preparation instructions.

The following criteria shall be met for the Reviews to close:

1) All objectives of the review have been achieved.
2) All RIDs have a disposition agreed with CSA and its project partners;
3) Actions (if any) have clear description, actionees, and due dates;
4) A forward plan or equivalent has been defined.

4.2.2.3 Work Authorization Meeting and Decisions

Milestones or Progress Review Meetings will also serve as Work Authorization Meetings to be held at the Detailed Design Review (DDR), Test Readiness Review (TRR), Pre-shipment Review (PSR), and Flight Readiness Review (FRR). These Work Authorization Meetings will serve as a basis for a decision to be made about whether or not to proceed with the follow-on activities of the Contract. These decisions will be based primarily on the review of deliverables associated with work packages found in Section 4.1 and the availability of compatible stratospheric balloon demonstration flights.

4.2.2.4 Final Review Meeting

The Final Review Meeting will be held at the end of the contract. The specific intent of this meeting will be to discuss in detail the results obtained (as compared to the agreed-upon system requirements) and the proposed follow-on activities.

The Final Review Meeting is intended to provide an opportunity for the Contractor, the PA, the TA, and other invited attendees to review and discuss in detail:

- The contents of the Final Data Package;
- The Executive and Technical Reports;
- Contractor Disclosure of Intellectual Property;
- Meeting presentation material;
- Prototypes, technical drawings, hardware, software, equipment, as applicable
- Asset declaration form; and
- Other items as deemed appropriate.

The Final Data Package is an assembly of final versions of all identified deliverables, plans and specifications, schematics, part lists and engineering data developed during the project.

The following criteria shall be met for the Reviews to close:

1) All objectives of the review have been achieved.
2) All RIDs have a disposition agreed with CSA and its project partners;
3) Actions (if any) have clear description, actionees, and due dates;
4) A forward plan or equivalent has been defined.

ACRONYMS

AI	Action Item
AIL	Action Item Log
AIT	Assembly Integration and Test
BIP	Background Intellectual Property
CDRL	Contract Data Requirements List
CNES	Centre National d'Etudes Spatiales
CSA	Canadian Space Agency
DID	Data Item Description
EBB	Elegant Breadboard
ECCC	Environment and Climate Change Canada
FIP	Foreground Intellectual Property
FOV	Field of View
FTS	Fourier Transform Spectrometer
GFE	Government Furnished Equipment
GiFOV	Ground Instantaneous Field of View
GSE	Ground Support Equipment
iFOV	Instantaneous Field of View
iFTS	imaging Fourier Transform Spectrometer
NDA	Non-Disclosure Agreement
NOSYCA	NOuveau SYstème de Contrôle d'Aérostats
PA	Project Authority
RD	Reference Document
RID	Review Item Discrepancy
ROM	Rough Order of Magnitude
SOW	Statement of Work
STDP	Science and Technology Development Program
TA	Technical Authority
TPM	Technical Performance Measure
TRL	Technology Readiness Level
TVAC	Thermal-Vacuum
UTLS	Upper Troposphere – Lower Stratosphere

UV-Vis	Ultra-Violet Visible
WAM	Work Authorization Meeting
WP	Work Package

APPENDIX A: DATA ITEM DESCRIPTION (DID)

DID-0001 Documents Naming Convention

PURPOSE:

To specify the documents naming convention

PREPARATION INSTRUCTIONS:
Documents shall contain 3 main components:

- Project Identifier,
- Contract Number, and
- Date Tracking Number.

WXYZ-TYPE-NUM-CIE_Contract Number_sent Date Tracking Number

Project Identifier

The project identifier shall contain:

- WXYZ: a 4- to 8-letter acronym of the project;
- TYPE: a 2-letter acronym according to the Table 8 below:

TABLE 8 – LETTER ACRONYM DEFINITION

PURPOSE:	**PURPOSE:**
AG	Agenda
MN	Minutes of meeting
PT	Presentation
PR	Progress Report
TN	Technical Note

- NUM: a three digit sequential number (e.g., 001, 002, etc.); and
- CIE: name of company (no space, no hyphen).

Contract Number

For example: _9F028-07-4200-03

Date Tracking Number

This is to reflect the submission date and shall follow the Year-Month-Day format. For example: _sent 2012-10-25 (for 25 October 2012).

Non-Disclosure

The documents will not be placed in the public domain, except for the Executive Report (see DID-0014). The Contractor shall indicate the following proprietary notices:

On the cover:

© Contractor, 20XX

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DID-0002 Project Management Plan

PURPOSE:
The Project Management Plan (PMP) is used to guide both project execution and project control.

The PMP is used by the Government to assess the adequacy of the Contractor's plan for management of the work and to provide a basis on which to monitor and assess the progress of the work. It shall be updated as required at all project reviews.

PREPARATION INSTRUCTIONS:
The PMP is used to:

- Guide the project execution;
- Document project planning assumptions;
- Document project planning decisions regarding alternatives chosen;
- Facilitate communications amongst stakeholders;
- Define key management reviews as to content, extent and timing; and
- Provide a baseline for progress measurement and project control.

When the Contract has specified delivery of another document that contains aspects of the required information, the PMP should summarize these aspects and refer to the other document.

The PMP shall contain the following information, as a minimum:

1) Introduction

a) Project Objectives;

b) Scope of the Plan; and

c) Applicable and Reference Documents.

2) Project Integration Management

This section shall describe the processes planned to be used to ensure that the various elements of the project are properly coordinated. It shall describe:

a) The overall project management strategy;

b) How the plan will be executed; and

c) Overall change control mechanisms.

3) Project Scope Management

This section shall describe the processes planned to be used to ensure that the project includes all the work required, and only the work required, to complete the project successfully.

The scope of work shall be broken down to all its project elements that organize and define the total scope of the project including subcontracted work, and shall be deliverable-oriented. Therefore, the Contractor shall provide an integrated Work Breakdown Structure (WBS) used during planning for estimating resources and scheduling the work. During the implementation phase, it is used for reporting and controlling costs and schedule.

The Contractor shall also prepare and maintain a Work Breakdown Structure WBS and Dictionary made up of Work Package Descriptions (WPDs) for every element to the lowest level of the WBS. Each WPD shall include, as a minimum:

a) A unique identifier traceable to the WBS;

b) A title;

c) The name of the individual responsible for completion of the work;

d) The scope of the work package;

e) The start date and duration;

f) Required inputs and dependencies;

g) A description of every activity covered by the WPD;

h) Assumptions;

i) Output and work package acceptance criteria;

j) Issue date;

k) Version number; and

l) List of deliverable with delivery milestone.

4) Project Time Management

This section shall describe the processes planned to be used to ensure timely completion of the project.

This section shall include the detailed project baseline schedule down to the activity level. The baseline schedule in the form of a Gantt chart shall include all elements of the WBS and shall depict all linkages and dependencies between tasks, durations, % complete, critical path, long lead items (if applicable) and constraints.

5) Project Cost Management

This section shall describe the processes planned to be used to ensure that the project is completed within the approved budget.

6) Project Quality Management

This section shall describe the processes planned to be used to ensure that the project will satisfy the needs for which it was undertaken.

7) Project Human Resources Management

This section shall describe the processes planned to be used to make the most effective use of the people involved with the project. It shall include a current Project Organizational Chart, showing personnel assignments by name and function and showing subcontractor reporting relationships, including a Project Manager, and a backup, who will be responsible for all aspects of the work.

8) Project Communications Management

This section shall describe the processes planned to be used to ensure timely and appropriate generation, collection, dissemination, storage, and ultimate disposition of project information.

9) Project Risk Management

This section shall describe the processes planned to be used to identify, analyze and respond to projects risks. It shall monitor areas of cost, schedule, programmatic and technical risk and shall implement appropriate risk responses, such as risk transfer, mitigation activities, or acceptance.

10) CADM Plan

The Configuration and Data Management (CADM) Plan establishes the Contractor's general approach, policies, and processes used for identifying the functional and physical characteristics of an item or system; controlling changes to those characteristics; recording and reporting documentation baselines and change processing, approval and implementation status; and verifying that the required functional and physical characteristics are achieved in the deliverable item or system.

11) Project Procurement Management

This section shall describe the processes planned to be used to acquire goods and services ("products") from outside the Contractor's organization, as applicable.

DID-0003 Meeting Agenda

PURPOSE:

To specify the purpose and content of a meeting.

PREPARATION INSTRUCTIONS:

The Meeting Agendas shall contain the following information, as a minimum:

1. Document Header:

a) Title;

b) Type of meeting;

c) Project title, project number, and contract number;

d) Date, time, and place;

e) Chairperson; and

f) Expected duration.

2. Document Body:

a) Introduction;

b) Opening Remarks: CSA;

c) Opening Remarks: Contractor;

d) Review of previous minutes and all open action items;

e) Project technical and/or scientific issues;

f) Project management issues;

g) Other topics; and

h) Set or confirm dates of future meetings.

DID-0004 Kick-off-Meeting Presentation

PURPOSE:

To present the Contractor's plan for carrying out the project and to address all significant issues.

PREPARATION INSTRUCTIONS:

The Kick-off Meeting Presentation shall contain the following information, as a minimum:

- Review major assumptions;
- Review contract deliverables;
- Review the work requirements;
- Review the work schedules;
- Review risk assessment and mitigation plan;
- Review Work Breakdown Structure and Work Packages;
- Review capability to deliver work packages at agreed cost and schedule;
- Discuss the BIP and review the provided list;
- Discuss the expected FIP and review the provided list (review Disclosure of FIP issues);
- Review basis of payment, and claim format;
- Review reporting requirements;
- Discuss any licensing issues;
- Other items as deemed appropriate;
- Presentation's slides to include the required copyrights and IP disclosure, and
- Meet the personnel assigned to the work.

DID-0005 Meeting Presentation

PURPOSE:

To present the current state of the project and to address all significant issues.

PREPARATION INSTRUCTIONS:

Review Meetings are held periodically throughout the Contract to provide formal opportunities for the Contractor, the PA, the TA, and other invited attendees to exchange information as well as for progress monitoring discussions and decision making. The presentations shall contain the following:

1 The contents of the Milestone and/or Progress Report;

2 The current % of completion and accomplishments;

3 The technical work of each task;

4 The current financial status (provide a table indicating planned vs. actual cash flow);

5 The performance results with respect to the system requirements;

6 The newly generated IP

7 Discuss relevant results achieved;

8 Project management issues; and

9 Risks

10 Other items as deemed appropriate.

11 Presentation’s slides to include the required copyrights and IP disclosure.

DID-0006 Action Items Log

PURPOSE:

The Action Item Log (AIL) lists, in chronological order, all items on which some action is required, allows tracking of the action, and in the end provides a permanent record of that Action Item (AI).

PREPARATION INSTRUCTIONS:

The AIL shall be in a tabular form, with the following headings in this order:

1. Item Number;
2. Item Title;
3. Open Date;
4. Source of AI (e.g. kick-off meeting, etc.);
5. Originator;
6. Office of Prime Interest;
7. Person responsible (for taking action);
8. Target/Actual Date of Resolution;
9. Status (Open or Closed);
10. Remarks

The date in column 9 will be the target date as long as the item is open, and the actual date once the item is closed using the following red-yellow-green stoplight method:

- ‘Green’ implying that the action item will be completed on-time.
- ‘Yellow’ implying that there exist an issue which will prevent meeting the deadline, and
- ‘Red’ implying that the action is past due.

Also, a chart indicating how many action items are open and how many are closed since the beginning of the project shall be produced

DID-0007 Monthly Progress Report

PURPOSE:

Monthly progress reports are used by the PA to monitor the work.

PREPARATION INSTRUCTIONS:

The report is a 2 pager that should be kept as brief as possible but should discuss the progress of the work and should include, but not be limited to, the following information:

Project Status (Page 1)

Program Status	**Pre-Month**	**Current Month**	**Notes**	**Highlights**
Technical				
Schedule				
Procurement				

Upcoming Milestones			**Highlights**
Milestone Description	*Baseline Date*	*Forecast Date*	

Top Risks		**Challenges**
Risk Description	*Mitigation Plan*	

DID-0008 Technical Review Deliverables

PURPOSE:

To provide documentation in support of the formal reviews.

PREPARATION INSTRUCTIONS:

Each review presentation package shall include as a minimum:

1) review notification;
2) agenda;
3) responses to action items and recommendations generated at prior reviews;
4) presentation material for the subject review;
5) analyses, reports, and other data required at the reviews
6) supporting material.

The presentation material shall include, as a minimum:

1) Detailed Design Review (DDR):

The purpose of the DDR is to demonstrate that the final detailed design will meet all requirements and is feasible within the cost and schedule constraints, and that the project is ready to proceed with the Implementation Phase. Costs may be discussed in a separate meeting.

a) analysis of the concept and other pertinent data generated in support of the iFTS design concept;

b) discussion of requirements and instrument simulator development plan;

c) review of project action items;

d) review of project risks;

2) Test Readiness Review (TRR):

The purpose of the TRR is to demonstrate that the test article hardware/software, test facility, ground support personnel, and test procedures are ready for testing, and for data acquisition, reduction, and control.

a) review of project action items;

b) review of project risks;

c) Review of the instrument simulator report;

d) review of retrieval algorithms;

e) test plans;

f) test procedures and data sheets;

g) test equipment descriptions;

h) diagrams;

i) test equipment calibration status; and

j) configuration status list of the hardware and software;

3) Pre-Shipment Review (PSR):

The purpose of the PSR is to demonstrate that planning and preparation for shipping the Flight System to the launch site is complete.

a) review of project action items;

b) review of project risks;

c) review of the Gondola integration and instrument check-out plan;

d) review of End Item Data Package; and

e) review of test failures and their close-out actions;

4) Flight Readiness Review (FRR):

The purpose of the FRR is to demonstrate that the Flight System is ready for flight.

a) review of project action items;

b) review of project risks;

c) balloon flight and commissioning sequence of operational activities and identification of corresponding procedures;

d) balloon flight and commissioning anomaly detection, resolution and correction procedures;

e) balloon flight and commissioning contingency scenarios and possible recovery actions;

f) balloon flight and commissioning system status target and criteria for completion;

g) status of any outstanding problems; and

h) safety status and any other issues.

DID-0009 Requirements Document

PURPOSE:

To define the Science, Ground User Interface, Flight, and Viewing requirements for the balloon mission. This will also provide a documented review of the Instrument and Interface requirements generated in the concurrent instrument development contract

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PREPARATION INSTRUCTIONS:

The Requirements Note of the iFTS payload development should be brief, and may be presented in a tabular format where appropriate. It shall contain the following information, as a minimum:

1. Science Requirements
2. Ground User Interface Requirements
3. Telemetry and Command Requirements
4. Viewing Requirements
    a) Derivation
5. Flight Requirements
    a) Altitude
    b) Communication and Telemetry
        i. Imagery Rate
        ii. Bandwidth
    c) Gondola Orientation
    d) Gondola Orientation Tolerances

6. Instrument and Interface Requirements Review

Note: As a deliverable, this document shall include the required proprietary notices.

DID-0010 Simulator Report

PURPOSE:

To report on the iFTS simulator.

PREPARATION INSTRUCTIONS:

The Simulator Report shall minimally contain the following information.

1. Model of As-Built Optical Performance
   a) PSF
   b) iFOV
   c) straylight
2. Calibration Data
3. Viewing Geometry
   a) attitude
   b) scan range
   c) scan rate (smear)
   d) gondola jitter/motion
4. Atmospheric Concentration Profiles (CO_2, CH_4, and CO)
5. Straylight Correction Algorithms
6. Raw Spectra
7. Corrected Spectra
8. Retrieval Algorithms
9. Instrument Performance Requirements assessment and validation
   a) spectral resolution (dispersion and PSF)
   b) spatial resolution (iFOV and PSF)
   c) straylight
   d) detector noise
10. Comparison with Flight Data
11. Instrument Recommendations

Note: As a deliverable, this document shall include the required proprietary notices.

DID-0011 Calibration and Test Plan

PURPOSE:

To assess the ability of the Calibration and Test plan to characterize performance requirements

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PREPARATION INSTRUCTIONS:

The Calibration and Test Plan of the iFTS payload shall minimally contain the following information. It is anticipated that Performance Criteria (3.(e)) will largely be limited to characterization of the instrument to be used for processing of the Flight Data, as opposed to the validation of performance requirements.

1. Relevant Requirements

2. List of Pre- and Post-Flight Optical Tests/Characterizations
    a) Spectral Transmission
    b) Spectral Resolution
    c) Responsivity/Flat-fielding
        i. Photo-Response Non-Uniformity Correction
        ii. Dark Current Non-Uniformity Correction (temperature dependence)
        iii. Acquisition Dependence (gain, integration time)
        iv. Saturation Characterization

3. Description of Optical Tests
    a) Descriptions
    b) Schematics
    c) Ground Support Equipment
    d) Analysis techniques and associated equations
    e) Performance Criteria

Note: As a deliverable, this document shall include the required proprietary notices.

DID-0012 Calibration and Test Report

PURPOSE:

To report the results of the calibration activities and assess readiness for flight.

PREPARATION INSTRUCTIONS:

The Calibration and Test Report of the iFTS payload shall contain the following information, as a minimum:

1. Pre-Flight Calibration Results
   a) Relevant Requirements
   b) Link to definition in Calibration Plan
   c) Results
   d) Analysis
   e) Performance

2. Assessment of Flight Readiness

3. Post-Flight Calibration Results
   a) Relevant Requirements
   b) Link to definition in Calibration Plan
   c) Results
   d) Analysis
   e) Performance

4. Assessment of Post-Flight Performance/Degradation

Note: As a deliverable, this document shall include the required proprietary notices.

DID-0013 Gondola Integration and Instrument Check-Out Plan

PURPOSE:

To confirm contractor understanding of the interfaces and the required verification activities prior to the flight-campaign at the Stratospheric Balloon base in Timmins, ON. To increase and confirm contractor preparedness for the Flight Campaign.

PREPARATION INSTRUCTIONS:

This brief document shall minimally contain the following information:

1. Review of gondola interfaces
    a) mechanical/mounting
    b) power
    c) communications

2. Integration Flow
3. Interface/Integration Verification Flow
    a) Command, Control, and Telemetry Verifications (operability)
    b) Post-Integration Performance Verifications (if required)
4. Concept of Operations
    a) Flight plan (altitude, azimuth angle variation, etc.)
    b) scan ranges
    c) scan rates
    d) integration times
    e) data downlink
    f) telemetry down link
5. Recovery instructions

DID-0014 Final Data Package

PURPOSE:

The Final Data Package is a collection of all documents to be presented by the Contractor at the end of the contract.

PREPARATION INSTRUCTIONS:

The Final Data Package shall consist of the final/revised version of all deliverables requested under the present contract (electronic copy). For example, with no limitation, the final data package should include the Detailed Design Report, the Final Report, the Executive Report, supporting software, presentations, minutes, and other required deliverables in their final revision.

1. FINAL REPORT

PURPOSE:

To fully describe the technical work performed, problems encountered and achieved objectives.

PREPARATION INSTRUCTIONS:

The Final Report for the iFTS balloon mission shall contain the following information, as a minimum:

I. Algorithm Descriptions:

0a) raw interferograms
0b) corrected interferograms
1a) spectra
1b) corrected spectra
2) column averaged mole fractions

II. Calibration Results
1. Pre-Flight Performance
2. Post-Flight Performance
3. Performance Assessment

III. Flight
1. Flight Configuration
2. Payload Integration Summary
3. Flight Timeline

a) Altitude
b) Geo-location
c) Gondola orientation

4. Instrument Telemetry
    a) Power Consumption
    b) Temperatures

IV. Flight Data
1. Raw Spectra
2. Calibrated Spectra
3. Trace Gas Column Mole Fractions

V. Flight Data Evaluation
1. Modelled spectra
2. Modelled Trace Gas Column Mole Fractions
3. Coincident measurements (if available)
4. Performance Assessment
    a) achievable spatial resolution with sufficient precision
5. Result Comparison with Simulator

VI. Recommendations
1. Algorithm Development
2. Instrument Development and Performance Recommendations
    a) straylight
    b) spectral resolution (dispersion, PSF, pixel dimensions)
    c) spatial resolution (iFOV, PSF)
    d) signal-to-noise ratio

Note: As a deliverable, this document shall include the required proprietary notices.

2. EXECUTIVE SUMMARY

PURPOSE:

To fully describe the entire project for dissemination in the public domain.

PREPARATION INSTRUCTIONS:

The Executive Report will be placed in the public domain (e.g., CSA's library, publication and/or website, to promote the transfer and diffusion of space technologies). The report shall not exceed ten (10) pages. Any confidential information concerning potential spin-off and commercialization, or any information that would constitute a public disclosure of the FIP should be placed in the Technical Report.

A recommended structure for the Executive Report is as follows:

1. Covering page (as per APPENDIX C);
2. Introduction;
3. Technical Objectives;
4. Approach / Project Tasks;
5. Accomplishments;
6. Technology:
    a) Description / Status of Technology (Initial TRL, Targeted TRL and Actual TRL at completion),
    b) Innovative Aspects, and
    c) Application Fields
    d) Next steps in the advancing the technology
7. Business Potential, Benefit and Impact on Company;
8. Ownership of Intellectual Property; and
9. Publications / References.

The CSA and the Contractor, or others designated by them, have the right to unrestricted reproduction and distribution of the Executive Report. The report shall include the following proprietary notice ("Owner of FIP" being either the CSA or the Contractor):

Copyright ©20XX “Owner of FIP"

> Permission is granted to reproduce this document provided that written acknowledgement to the "Contractor name" or the Canadian Space Agency is made.

DID-0015 Background and Foreground Intellectual Property (BIP/FIP) Disclosure Report

PURPOSE:

The BIP/FIP Disclosure Report serves to identify FIP produced under the Contract with the CSA, as well as any BIP elements that were used to develop the FIP.

PREPARATION INSTRUCTIONS:

The Contractor shall complete Table 9 for the report to be provided with the proposal (BIP). The report to be provided at the end of the contract shall include Table 9, Table 10, and Table 11 (BIP/FIP).

Contractor Disclosure of Intellectual Property

Instructions to the Contractor

Identification

The Contractor shall respond to the 7 following questions when Foreground Intellectual Property (FIP) is created under the Contract with the CSA.

1. Contractor Legal Name:
2. Project Title supported by the Contract:
3. CSA Project Manager of the Contract:
4. Contract #:
5. Date of the disclosure:
6. Will there be Contractor's Background Intellectual Property brought to the project:
   - ☐ Yes_ Complete Table 9 attached (Disclosure of Background Intellectual Property)
   - ☐ No
7. For Canada's owned IP, are there any IP elements that, to your opinion, would benefit from being patented by Canada?
   - ☐ Not applicable, FIP resides with the Contractor
   - ☐ Yes_ Complete Table 11 attached (Canada's Owned Additional Information)
   - ☐ No

For the Contractor _____ *Signature*	 _____ *Date*

For the CSA Project Manager _____ *Signature*	 _____ *Date*

BIP

- At the end of the Contract, the Contractor shall review and update the BIP disclosure (Table 9) when applicable before closing of the Contract. Only the BIP elements that were used to develop the FIP elements should be listed.

FIP

- At the end of the Contract, the Contractor shall complete Table 10 (Disclosure of the FIP developed under the Contract).
- If Canada is the owner of the FIP and identifies some FIP elements that would benefit from being patented by Canada, the Contractor shall also complete Table 11 (Canada's Owned FIP Additional Information).
- The Contractor shall sign below and deliver the completed Contractor Disclosure of Intellectual Property to the CSA Project Manager of the Contract for his/her approval before closing the Contract.

General Instructions for BIP and FIP tables

- Tables shall be structured according to the CSA IP form provided.
- Each IP element shall have a unique ID # in order to easily link the elements of the different tables.
- Titles of IP elements shall be descriptive enough for project stakeholders to get a general idea of the nature of the IP.
- Numbers and complete titles of reference documents shall be included.

Definitions

Intellectual Property (IP): means any information or knowledge of an industrial, scientific, technical, commercial artistic or otherwise creative nature relating to the work recorded in any form or medium; this includes patents, copyright, industrial design, integrated circuit topography, patterns, samples, know-how, prototypes, reports, plans, drawings, Software, etc.

Background Intellectual Property (BIP): IP that is incorporated into the work or necessary for the performance of the work and that is proprietary to or the confidential information of the Contractor, its subcontractors or any other third party.

Foreground Intellectual Property (FIP): IP that is first conceived, developed, produced or reduced to practice as part of the work under the Contract.

Background Intellectual Property (BIP)

TABLE 9 - DISCLOSURE OF BACKGROUND INTELLECTUAL PROPERTY (BIP) BROUGHT TO THE PROJECT

BIP ID#	Project Element	Title of the BIP	Type of IP	Type of access to the BIP required to use/improve the FIP	Description of the BIP	Reference Documentation	Origin of the BIP	Owner of the BIP
Provide ID # specific to each BIP element brought to the project e.g. BIP-CON-99 *where CON is the contract acronym*	*Describe the system or sub system in which BIP is integrated (e.g. camera, control unit, etc)*	*Use a title that is descriptive of the BIP element integrated to the work*	*Is the BIP in the form of an invention, trade secret, copyright, design, patent?*	*Describe how the BIP will be available for Canada to use the FIP (e.g. BIP information will be incorporated in deliverable documents, software will be in object code, etc)*	*Describe briefly the nature of the BIP (e.g. mechanical design, algorithm, software, method, etc)*	*Provide the number and fill title of the reference documents where the BIP is fully described, The reference document shall be available to Canada. Provide patent# for Canada if BIP is patented.*	*Describe circumstances of the creation of the BIP Was it developed from internal research or through a contract with Canada? If so, provide contract number.*	*Name the organization that owns the BIP. Provide the name of the subcontractor if not owned by the prime contractor.*

Foreground Intellectual Property (FIP)

TABLE 10 - DISCLOSURE OF THE FOREGROUND INTELLECTUAL PROPERTY (FIP) DEVELOPED UNDER THE CONTRACT

FIP ID #	Project Element	Title of FIP	Type of FIP	Description of the FIP	Reference documentation	BIP used to generate the FIP	Owner of the FIP	Patentability
Enter an ID # specific to each FIP element *e.g.FIP-CON-99* *where CON is the contract acronym*	*Describe the system or sub-system for which the FIP element was developed (e.g. a camera, ground control, etc)*	*Use a title that is descriptive of the FIP element.*	*Specify the form of the FIP e.g. invention, trade secret, copyright, industrial design, patent*	*Specify the nature of the FIP e.g. software, design, algorithm, etc?*	*Provide the full title and number of the reference document where the FIP is fully described. The reference document shall be available to Canada*	*BIP referenced in Table 9 e.g. BIP-CON-2, 15*	*Specify which organization owns the FIP e.g. Contractor, Canada* or Subcontractor.* *Provide the name of the subcontractor if not owned by the prime contractor.* **If Canada is the owner of the FIP, complete Table 11 below* *Provide reference to contract clauses that support FIP ownership.* *Provide reference to WPDs under which the technical work has been performed.*	*In the case where the IP is owned by Canada, indicate with an "X", any IP elements described is patentable and complete Table 11 only for this IP.*

TABLE 11 - CANADA'S OWNED FIP ADDITIONAL INFORMATION

FIP ID #	Title of FIP	Aspects of FIP that are novel, useful and non-obvious	Limitations or drawback of the FIP	References in literature or patents pertaining to the FIP	Has the FIP been prototyped, tested or demonstrated? (e.g. analytically, simulation, hardware)? Provide results	Inventor(s)	Was the FIP disclosed to other parties?
ID# should be same as corresponding FIP element in Table 10	*Title of FIP should be same as corresponding FIP element in Table 10*	*How is the FIP addressing a problem (useful) and what is thought to be novel in this solution (novel)?*	*Describe the limitations of present apparatus, product or process*	*Provide references in published literature or patents relating to the problem or subject if any.*	*Describe briefly how the process, product or apparatus performed during testing or simulation. Provide reference document # where the performance is compiled if applicable.*	*Provide name and coordinates of the person(s) who created the FIP*	*Has any publication or disclosure of the FIP or any of its elements been made to third parties? If so, provide when, where and to whom.*

APPENDIX B: ASSET DECLARATION FORM - PROTOTYPES AND EQUIPMENT

Equipment Declaration: The Contractor shall fill out the following form so as to identify all equipment procured under this contract.

TABLE 12: EQUIPMENT DECLARATION FORM

Equipment #	Equipment description	Inventory #	Acquisition Value	Currency	Acquisition date	Manufacturer	Country	Model #	Serial #

Prototype List: The Contractor shall provide a list of all prototypes developed under this contract.

TABLE 13: PROTOTYPE DECLARATION FORM

Prototype Name	Prototype description

The decision regarding the delivery of any prototype is to be made by the CSA at the end of each contract completion

Note: Canada may reserve the right not to request compensation or replacement of government-furnished equipment (GFE) if the use of the said equipment is an integral part of the proposed research and development study or work.

APPENDIX C: REPORT DOCUMENTATION PAGE

Canadian Space Agency **Agence spatiale canadienne**	**REPORT DOCUMENTATION PAGE**
Report Date:	
Title:	
Author(s):	
Performing Organization(s) Name and Address(es):	
Contract # and Title:	
Sponsoring Agency Name(s) and Address(es): Canadian Space Agency 6767 Route de l'Aéroport Saint-Hubert, Québec, Canada J3Y 8Y9 Tel: (450) 926-4800 **Scientific Authority:** **Project Manager:**	
Abstract:	
Key Words:	
Supplementary Notes:	
Distribution/Availability:	