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LADD TEST ARTICLE (LTA) GROUND SUPPORT EQUIPMENT (GSE) REQUIREMENTS DEFINITION DOCUMENT

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Prepared for:

CANADIAN SPACE AGENCY
DIRECTORATE OF SPACE MECHANICS
3701 CARLING AVE.
P.O. BOX 11940, STATION H
SHIRLEY'S BAY
NEPEAN, ONTARIO
K2H 8S2

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Spar Aerospace Limited
Satellite and Communications Systems Division
21025 TransCanada Highway
Ste-Anne-de-Bellevue, Quebec
Canada H9X 3R2
Telephone: (514) 457-2150
Fax: (514) 457-2724
Telex: 05-822792

Government of Canada Gouvernement du Canada

CSA CONTRACTOR REPORT CSA-DSM-CR-93-021

CANADIAN SPACE AGENCY

TITLE: LADD TEST ARTICLE (LTA) GROUND SUPPORT EQUIPMENT (GSE) REQUIREMENTS DEFINITION DOCUMENT

AUTHOR(S): SPAR PROJECT STAFF

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PREPARED BY: SPAR PROJECT STAFF

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1.0 Introduction

1.1 Contractual Context

This document is submitted to the Directorate of Space Mechanics of the Canadian Space Space Agency (CSA/DSM) in response to SOW requirement Task 3.2.1 of Contract 9F011-2-0975/00, dated 27 May 1992.

1.2 Background

The most important subsystem of the spacecraft envisioned for the Space-Based Radar (SBR) is the radar antenna. Over a number of years, Rome Laboratory (USAF) funded the development of a flight-qualified deployable radar array test membrane known as the Lens Antenna Deployment Demonstration (LADD) Test Article (LTA).

Rome Laboratory will provide the LTA on a loan basis for the structural dynamics testing in Canada and will participate in the testing on the basis of an international agreement between the United States and Canadian governments.

The testing of this structure provides a significant step forward in the credibility and acceptability of the testing methods and techniques, particularly the non-contact measurement (NCM) systems, being developed by CSA/DSM

2.0 Ground Support Equipment

Ground Support equipment (GSE) is necessary to support the LTA, the NCM systems and other test equipment during the structural dynamics testing, either in one of the integration areas or inside the 22'x 35'thermal vacuum chamber of the CSA David Florida Laboratory (DFL).

To this end, the GSE shall be capable of easy assembly and dis-assembly, easy to use and compatible with the following environments:

- DFL Clean Areas

Temperature	23 ± 5 degrees Celsius
Relative Humidity	60% maximum
Cleanliness	Federal Standard 209C Class 100000

- Thermal Vacuum Chamber

Temperature	23 ± 5 degrees Celsius
Pressure	1 - 760 torr

3.0 GSE Requirements

3.1 Test Article Support

The test article support structure (TASS) is required to support any of the following test articles or other items of GSE inside the 22'x 35' thermal vacuum chamber:

- LTA on its Ground Support Fixture
- Test membrane support frame complete with any of the proposed test membranes
- Laser system main support frame (MSF)

The TASS shall be capable of interfacing with the four isolated hardpoints located in the bottom bell of the thermal vacuum chamber. Details of the hardpoints are contained in CSA/DFL drawing M-13,371-E.

The TASS shall be of sufficient strength to support any of the test articles and the laser system without visible distortion or failure. The design of the support structure shall be such as to be readily analysed by the finite element method in order to be able to predict its characteristics during a modal test of the test article. The fundamental resonance of the combined TASS/MSF assembly shall be outside the test frequency range of 0 to 10 Hz.

The TASS shall be sufficiently large as to permit the mirrors of the NCM system (ref. para.3.3) to be positioned at a distance within the range of 18 to 72 inches away from the test article.

3.2 Laser System Main Support Frame (MSF)

The Laser system MSF is required to be capable of standing freely in one of the CSA/DFL clean areas or of being secured to the TASS (ref. para. 3.1) inside the thermal vacuum chamber.

Attachments between the MSF and the TASS shall be sufficiently rigid so as to prevent movement of the laser system affecting the accuracy of measurement during a dynamic structural test. The goal is for the first natural frequency of the MSF when attached to the TASS and supporting the laser mirror frame (LMF) in any of its specified positions to be greater than 15 Hz.

The MSF shall be of sufficient height and width to enable the laser system to cover the LTA membrane which measures 20'x 8'and the test membranes which measure up to 8'x 7'6". Any bracing structure necessary to achieve the MSF frequency goal shall be capable of interfacing with the TASS and the DFL seismic block. The brace shall in no way interfere with the test article when installed at the specified distance from the MSF or with the chamber shrouds or staging.

Consideration shall be given to constructing the MSF and brace structure (if required) from more than one piece in order to facilitate movement throughout the DFL and installation in the chamber. Re-assembly shall be readily achievable.

3.3 Laser NCM System Mirror Frame

The laser NCM system mirror frame (LMF) is required to support the mirrors and the laser device in the correct orientations. The LMF shall be a rigid framework to ensure dimensional stability and shall be capable of being located in various locations on the MSF to suit the size of the test article to be measured.

The interface with the MSF shall be at four locations which will incorporate adjustments to ensure alignment of the laser beams with the desired points on the test article. The adjustment capability shall include vertical translation and all three rotational degrees of freedom.

The LMF will consist of a basic sub-frame to which is attached a number of I-beams. The I-beams can attach to the sub-frame in either a vertical or horizontal pattern to suit the test. One I-beam which will generally be placed in the centre of the pattern will be extended on one end to incorporate a rigid attachment for the CSA/DSM supplied laser vibrometer unit. This attachment will be via a circular plate which will serve as one end of an airtight container to enable the laser unit to be operated in vacuum.

The central I-beam will also provide attachments for the primary mirrors on adjustable brackets, these mirrors each reflecting two laser beams through 90 degrees towards mirrors mounted on the other I-beams. The secondary mirrors will be positioned to accept one laser beam each and reflect it through 90 degrees in a direction at right angles to the plane of the LMF. The secondary mirrors will also be attached via adjustable brackets which will have provision for focussing lenses.

Both the I-beams and the sub-frame will incorporate a selection of attachment holes on a regular grid pattern to provide the adaptability to suit a variety of test article sizes and configurations. The central I-beam is required to be one inch greater in depth than the secondary I-beams in order to simplify alignment of the laser beams.

The laser unit container will consist of a circular aluminum tube with end flanges to suit the attachment of end plates. As mentioned above, one end plate will be bolted to the central I-beam and will incorporate a precision glass window for the laser beam. The other end plate will incorporate two holes for the passage of cooling air when inside the thermal vacuum chamber. The air will be supplied to one hole via a chamber penetration and flexible hose, the air and the laser control and data cables passing out through the other hole via flexible hose to the same chamber penetration.

3.4 Exciter Support Frame

The exciter support frame (ESF) is required to locate on any set of four hardpoints at the same level on the thermal vacuum chamber walls. Provision is to be made for suspending exciters from the ESF via flexible links. The number of exciters required simultaneously is expected to be two but the ability to increase this number to four shall be considered in the design of the ESF.

The flexible links between the ESF and the exciters shall support the weight of the exciters and allow the exciters to move back and forth along the direction of thrust over a maximum distance equal to the stroke of the exciter. Lateral movements shall be allowed but shall be restricted to less than 10% of the axial movement.

Provision shall be made for adjustment in the length of the flexible links to facilitate alignment of the exciter stinger with the required excitation point on the test article.

The CSA/DFL exciters will have the grease on their internal surfaces removed prior to installation in the thermal vacuum chamber. This will obviate the need for containers, hoses and cooling air to maintain the exciters at ambient pressure.

A chamber penetration plate will be required for the routing of the exciter power, control and data cables to the exterior of the chamber.

3.5 Photogrammetric Camera Support

A second NCM system is required by CSA/DSM in order to provide backup and correlation with the laser vibrometer system. This second system consists of a photogrammetry system using video cameras.

A minimum of two and a maximum of four video cameras are to be placed inside the chamber with a field of view covering the rear surface of the membrane under test. Air tight containers shall be provided for these cameras, each container providing a mounting point for one camera and an optical glass window to suit the camera aperture.

Each container will consist of a circular aluminum tube with end flanges to suit the attachment of end plates. One end plate will contain the window mentioned above, the other will incorporate two holes for the passage of cooling air. The air will be supplied to one hole via a chamber penetration and flexible hose, the air and the camera control and data cables passing out through the other hole via flexible hose to the chamber penetration.

Each camera container will be attached to a horizontal beam that is bolted onto the vertical guide rails for the chamber access staging. Each container attachment will make provision for manual adjustment of the camera angle so that the required field of view can be achieved prior to test. Provision shall also be made for the container attachment to the beams and the beam attachment to the rails to altered to suit a variety of test configurations.

3.6 Mirror Frame Lifting Beam

The LMF is initially attached to the MSF prior to installation of the test article. However, for tests on large test articles, the LMF will need to be re-positioned a number of times so that all of the required areas of the test article are covered.

Due to the assymetric weight distribution caused by the laser container and the need to re-position the LMF in close proximity of the test article, an adjustable lifting beam is required.

The beam shall attach to the LMF at the attachment points to the MSF for consistent loading of the LMF. The attachment fitting for the crane shall be adjustable along the length of the beam to suit the center of gravity of the LMF and thus provide a stable, level lift. However, with the LMF attached to the MSF, the lifting beam crane attachment fitting will have to be adjusted to a central position on the beam prior to disconnection from the LMF to prevent tipping of the beam. The reverse procedure will apply for attachment of the beam to the LMF.

3.7 General GSE Requirements

With the exception of the lift beam, all items of GSE will be subjected to 'soft' vacuum conditions inside the thermal vacuum chamber, these conditions generally involving evacuation using the roughing pumps only, a pressure in the range 1 to 50 torr.

In order to prevent the possibility of contamination of the chamber, all items shall be constructed from thermal vacuum compatible materials and shall not have any loose particles.

For steel items, this will involve painting all external surfaces with vacuum compatible paint. Aluminum items may be left unpainted providing they are clean and are not to be positioned close to the path of the laser beam. All such items, of either material, are required to be painted matt black to reduce reflections.

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This report defines the requirements for the ground support equipment (GSE) required for the structural dynamics testing of the LADD Test Article (LTA). This testing is to be done inside the 22' X 35' thermal vacuum chamber which is part of the CSA David Florida Laboratory. The GSE consists mainly in the existing VAMS platform (which has to be modified) onto which the LTA, the main frame and mirror frame (with a container) of the multi-channel laser measurement system are to be supported.

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