MetOp Second Generation MWS Calibration Rig

Phase Separator Specification

Issue 3.0

	Name	Signature / Date
Prepared by		
Reviewed by		
Approved by		
Approved by		

STFC Rutherford Appleton Laboratory
RAL Space
Harwell Oxford
Didcot
Oxfordshire OX11 0QX
United Kingdom

CHANGE LOG

Date	Issue	Revision	Pages	Reason for change
03 Jul. 2017	0	1	All	First draft created.
18 Aug. 2017	1	0	All	Additional content added for First Release
12 Oct. 2017	1	1	6, 7, 10	Update following RID Technical-9
23 Oct. 2017	2	0	All	Release of version 2.0
12 April 2018	3	0	10,11,12,14	Updated for tender

CONTENTS

FIGURES

Applicable Documents

AD #	APPLICABLE DOCUMENT TITLE	DOCUMENT ID	ISSUE
1	BS EN 13445 (Parts 1-5) : 2014	Unfired Pressure Vessels	2014
2	PD 5500:2012+A3:2014	Specification for Unfired Fusion Welded Pressure Vessels	2014
3	PER 1999	Pressure Equipment Regulations	1999
4	SC33	RAL SPACE SHE Code – Safety of Pressure and Vacuum Systems	1.6
109*	CAIT.04361.ASTR	Generic System MGSE Specification	1.0
5	2001/95/EC	General Product Safety Directive (GPSD)	2001
6	93/68/EEC	CE Marking Directive	1993

*Documents available to bidder

Reference Documents

RD #	REFERENCE DOCUMENT TITLE	DOCUMENT ID	ISSUE
1			

*Documents available to bidder

Abbreviations and Definitions

CRES	Corrosion Resistant Steel
EGSE	Electrical Ground support equipment
GN_2	Gaseous Nitrogen
LN_2	Liquid Nitrogen
MWS	MicroWave Sounder
RAL	Rutherford Appleton Laboratory
RCTR	Radiometric Calibration Test Rig
STC-3m	3m diameter Space Test Chamber at RAL Space
TA	Target Assembly
TVAC	Thermal Vacuum Chamber
VCR	Type of metal gasket face seal fitting

1. INTRODUCTION

1.1 Purpose

STFC/RAL Space is designing and building the Radiometric Calibration Test Rig (RCTR) for the MicroWave Sounder (MWS) instrument to be flown on the MetOp Second Generation mission.

The RCTR includes two calibration Target Assemblies (TA) that require very accurate thermal control, and will rely on a constant supply of liquid nitrogen at a controlled pressure. To this end, a Phase Separator is required.

1.2 Scope

This document is a specification for the design, manufacture, fabrication, testing, inspection and delivery of the LN_2 phase separator.

2. PHASE SEPARATOR DESCRIPTION

The Phase Separators are shown schematically in Figure 2-1. The circuitry shown in these schematics are for example only – the Bidder is expected to propose all circuitry required to operate and safeguard the LN_2 supply system from interface point with the facility up to the interface point at the Target Assembly within the TVAC chamber, and this design will be approved by RAL SPACE at the final design review. The interface between the Phase Separators and the facility is shown as a purple dashed line. The Phase Separator is assumed to constitute all the equipment enclosed in this line.

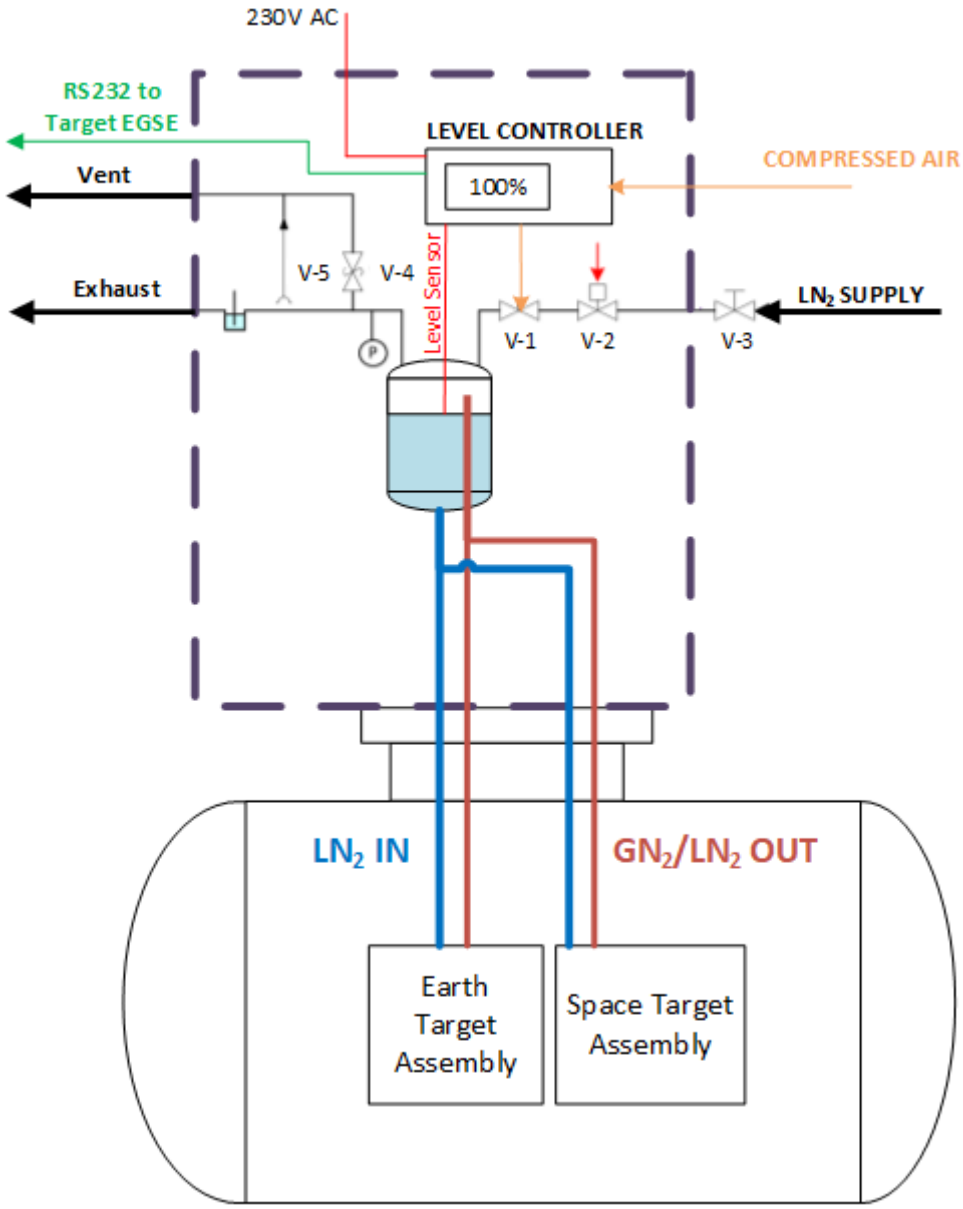

Figure 2-1 Block diagram for the Phase Separator

The system is based on a reservoir of liquid nitrogen (LN2) that is used to gravity-feed the Target Assemblies. The reservoir is fed with lines from a facility source. The supply to the reservoir can be switched on and off remotely with the solenoid valve V-2. A pneumatic needle valve (V-1) on the supply line is used to control the flow of LN2 into the reservoir. The valve uses feedback from a level sensor to maintain a constant level in the reservoir during operation.

The level controller is powered by a mains 230V AC supply. The exhaust from the reservoir vents directly to atmosphere. The exhaust line contains a pressure gauge, a pressure-relief valve (V-4) and a burst-disc (V-5) to limit the maximum possible pressure in the system to around 0.5 bar above atmospheric. It also contains an LN2 sensor to flag if LN2 is accumulating in the exhaust line, indicating a possible overfill of the reservoir. In such an event, the solenoid valve V2 can be closed automatically to stop the filling process.

2.1 Pipe Interfaces

- All connections input/output go through a 16.5 inch Conflat Flange (see Figure 2-3), which is mounted on the top of the STC-3m chamber. This flange itself is not considered as part of the phase-separator system and does not have to be provided by the Bidder.
- Connectors from facility's LN2 supply are Cajon 8 VCR, though connections to the flange and to the Target Assemblies within the chamber are DN40CF for outlets and ½ inch VCR for inlets. Any adaptors required to interface between the facility and the phase-separator system are to be provided as part of this bid.
- The facility will provide LN2 supply to phase-separator system up to the interface point which is either the Cajon 8 VCR connector, or to the adaptor to the Bidder's choice of connector on the flange; exhaust/venting; and all inlet/outlet pipework within chamber, including that going from phase-separator to the Target Assemblies.
- The LN2 supply is from a supply tank, which is located by 27m of vacuum-insulated pipeline to the interface point (at connection to flange). The LN2 pressure at this interface point is 3.5-3.8 barg.
- The phase separator shall fit on a flat mezzanine above the vessel within a footprint of 1.2 m by 1.2 m. The maximum height shall be less than 1.5m.
- The temperature of the LN2-IN from the phase separator into the target assemblies shall not be higher than 78K.
- Figure 2-1 is for illustration only. There is no requirement for the phase separator to be mechanically attached on top of the vessel.

An overview of the Liquid Nitrogen (LN_2) system for the RCTR is shown in Figure 2-2.

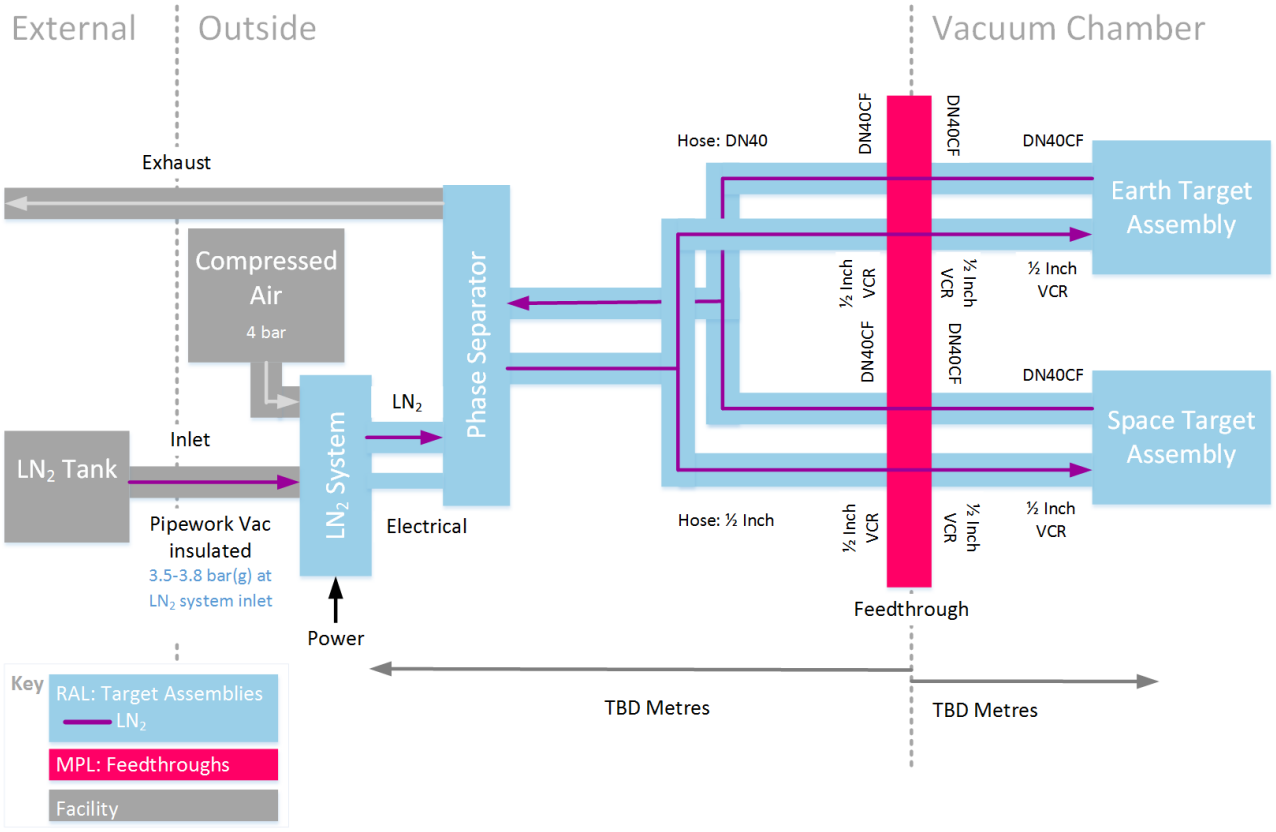

Figure 2-2 RCTR LN_2 System Overview

The Interface Flange location for the LN2 system pipework is at approx. 45 degrees, Southwest end of chamber. See Figure 2-3.
The details of the piping and ports for the LN_2 system are as follows:

- Feedthrough LN_2 Inlets
  - Inside TVac Port: VCR ½ inch
  - Outside TVac Port: VCR ½ inch
- Feedthrough LN_2 Exhausts
  - Inside TVac Port: DN40CF
  - Outside TVac Port: DN40CF

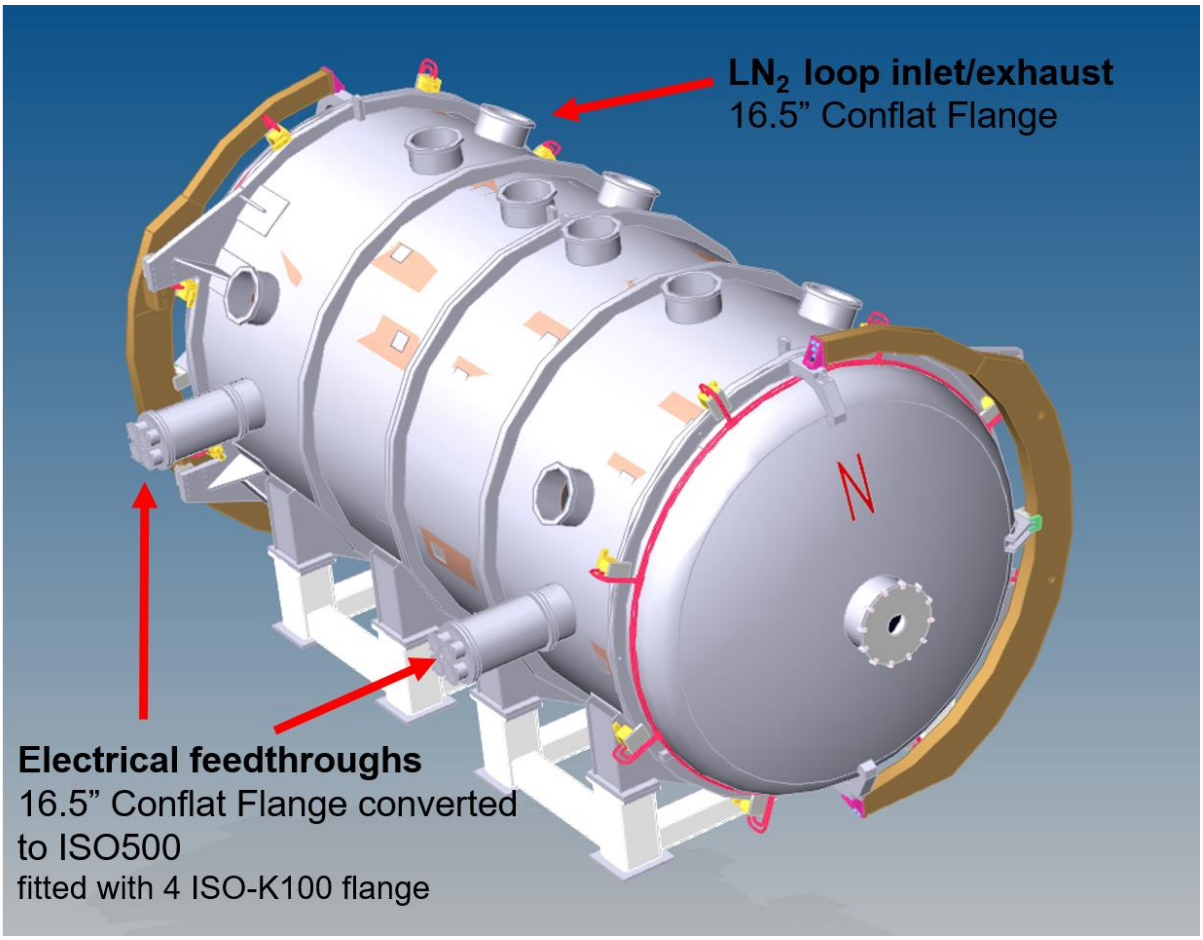

Figure 2-3 Overview of feedthrough position on STC-3m chamber (EGSE SIDE)

3. PHASE SEPARATOR OPERATION

The sequence of operations needed to fill the phase separator (and start cooling the TAs) is given below.

1. Turn on the compressed air supply to the LN2 needle valve
2. Turn on the LN_2 level control system
3. Open the LN_2 isolation valve (manual valve)
4. Open the solenoid operated LN_2 valve (remotely)
5. At this point the phase separator should start filling
6. Check that GN_2 is venting through the exhaust line
7. Monitor the pressure inside the phase separator (remotely)
8. Monitor the temperature of the TA LN_2 jacket (remotely). It should show a rapid drop in temperature.

4. GENERAL DESIGN REQUIREMENTS

4.1 Environment

The Phase Separator will operate in normal ambient lab conditions, with temperatures ranging from 15 to 25 °C. Exposure to corrosive fluids or gasses is not foreseen. The phase separator should have a cleanliness compatible with an ISO-5 cleanroom environment.

4.2 Volume

The operating volume of the reservoir is ~20 litres.

4.3 Fill Rate

The initial fill should take less than 1 hour (TBC - also depending on the facility supply flow rate). The boil-off rate from the two Target Assemblies combined is estimated to be about 200L of LN_2 per hour.

4.4 Mechanical envelope

The LN2 system excluding pipework to the vessel and facility LN2 supply should fit within a volume defined by a footprint of 1.2 m by 1.2 m and a maximum height of 1.5m.

4.5 Accommodation

The system shall be accommodated within the interface as described in 2.1.

4.6 Operating Pressure

The phase separators are open to atmosphere, and this is the nominal operating pressure. However, if the pressure inside the reservoir increases due to a fault condition it must never be allowed to exceed 2 bar absolute, otherwise damage to the Target Assemblies may result.

4.7 Redundancy

A redundant level sensor in the reservoir is required to increase overall reliability of the system.

4.8 Thermal Insulation

All pipes, connections and valves that are exposed to air shall use vacuum-insulated lagging to prevent ice building up. All mounting points shall incorporate thermally-isolating materials.

4.9 Pressure Vessel Design

The Phase Separators shall comply with the requirements of AD1, 2, 3 and 4. They are considered to be pressure vessels when pressurised to their maximum pressures, or when cavities are evacuated for thermal insulation.

4.10 Leak rate

The Phase Separator and its pipework should be tested and have a leak rates of less than 1e-8 mbar L/s.

4.11 Lifting

The contractor shall assess lifting requirements, and propose lifting points and any lifting equipment required. The contractor shall proof-test the lifting equipment or provide lifting certificate in accordance with BS standards and international standards for lifting equipment. This equipment is deliverable. Test report to be provided by the bidder.

4.12 Transport

The contractor shall propose, design, manufacture and deliver any equipment or containers necessary to deliver the Phase Separator by road transport within the UK. Packaging materials shall be clean, and protect the hardware from contamination and weather.

4.13 Storage

The contractor shall propose, design, manufacture and deliver any equipment or containers necessary to store the Phase Separators for up to 25 years in lab conditions.

The equipment in its packing case(s) shall be capable of withstanding without damage, or, degradation of performance transportation by air and road in the following conditions to agreed levels:

a. Temperature from -10°C to +60°C.
b. Barometric pressure from 970 mbar to 1088 mbar during non-vacuum ground operation and storage
c. Barometric pressure from 200 mbar to 1088 mbar during transport
d. Relative humidity 90% in the temperature range -10°C to +60°C, non-condensing.
e. Transportation vibrations as specified in AD109 for ground equipment.
f. Handling shocks and drops as per AD109.
g. Atmospheric conditions such as rain, snow, sleet, hail, ice, fog, smoke, wind, ozone, sand, dust, sunshine, salt and corrosive atmosphere in any probable combination.

4.14 Fill Control and Monitoring

Control and monitoring shall be via a computer positioned remotely, connected to the Phase Separator by an RS232 interface. In particular, the phase separator controller (level display) is to be readable via RS232 so that the level can be monitored on the overall Target EGSE software and an alarm can implemented upon it if needed.

4.15 Power Loss

In the event of a power loss, or communication loss with the remote computer, the system shall fail in a safe way (i.e. LN_2 flow into the reservoir shall stop).

4.16 Lifetime

The Phase Separators are required to operate (not continuously) for 25 years. Where possible, long-life components shall be chosen in the design process. For perishable components, standard stock items shall be used such that spares can be procured at a later date.

4.17 Documentation

The following documentation shall be provided by the Manufacturer to conform to AD5 and AD6:

- Certificate of Conformity
- Declaration of Conformity
- Safety Assessment Report
- Design definition document (including assembly drawings)
- User manual detailing the operation of the system, as well as transport, handling and installation
- Proof loading certificates where required
- Certificates of inspection (welds etc…)
- Stress analysis report
- Inspection report
- Essential Health and Safety Requirements
- Maintenance Schedule (as required)

Manufacturer's data shall be supplied for all components, including operating manuals, a full parts list and maintenance requirements.
A risk assessment that covers transport, storage, handling, installation and operation of the Phase Separators.

4.18 CE Marking

The Phase Separators are required to be CE Marked.

5. 7 MANUFACTURING REQUIREMENTS

5.1 Codes

The Contractor shall comply with the relevant clauses in AD2 and AD3 regarding manufacture and workmanship of pressure vessels.
Any deviation by the Contractor from their drawings or from this Specification shall be formally approved by RAL SPACE prior to manufacture.

5.2 Welders and Weld Procedures

All welding procedures and welder approval shall be to EN13445:2014 part 5 section 6.5.2 (AD1)
The Contractor shall ensure that the vessel is delivered free from sharp edges and burrs.

6. INSPECTION AND TESTING

The Contractor shall be responsible for arranging weld inspection by an independent inspection authority. Weld inspection is as per AD1 and AD2.
The Contractor shall be responsible for arranging any pressure testing required by AD1 and AD2. This shall be witnessed by an independent inspection authority.
The Contractor shall be responsible for leak checking. This test shall be witnessed by RAL SPACE, with 7 days' notice given to RAL SPACE beforehand, and the test report shall be supplied to RAL SPACE.
The Contractor shall be responsible for the functional testing of the Phase Separator. The functionality of the system shall be demonstrated to RAL SPACE at a final Acceptance Test, and this test report shall be supplied to RAL SPACE. This test shall demonstrate:

- Filling the Phase Separator initially.
- Level control when full. (This is to be discussed at KO with RAL Space)
- Level control during a steady-state period where boil-off is occurring due to applied heat. (This is to be discussed at KO with RAL Space)
- Emptying the Phase Separator (by boil-off).
- User interfaces.
- Valves and their operation.
- Lifting, handling, transport and storage facilities.

All testing shall be conducted at the Contractor's premises.

7. DELIVERY

Delivery is to:
Stores Officer
Building R56
RAL SPACE - Rutherford Appleton Laboratory
Harwell
Oxford
OX11 0QX
United Kingdom