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C3Po1F-07: Thermal Control Units for Space Vacuum Chambers

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Criotec Impianti awarded the contract for the design, manufacturing, installation and commissioning of the temperature control system of the Large Earth Observation Thermal Vacuum chamber (LEO LARGE TVC) under construction at Customer premises.

For this project Criotec Impianti developed two different sizes of so-called Thermal Control Units (TCUs) that will be used for the thermal conditioning, in both cold and hot conditions, of the vacuum chamber's thermal shrouds, baseplate and of the thermal ground support equipment units under test (UUT TGSE).

The technical specification for the thermal vacuum chamber requests an operative temperature range between 82K to 333K with a spatial uniformity up to 2K on the baseplate and a maximum of heating/cooling rate of 2K/min on the shrouds.

To achieve these requirements, Criotec Impianti designed the TCUs as vacuum insulated valve boxes operating with gaseous helium as working fluid.

Each TCU consists of the following main components:

- a warm temperature helium blower fan providing the requested gas flow rate
- a cold heat exchanger cooling down the working fluid using liquid nitrogen during the low temperature operation
- an electrical heater to heat up the working fluid during the high temperature operation and for the precise temperature control (± 1 K) during the operations at steady state conditions
- a regenerative heat exchanger used as economizer in order to reduce the liquid nitrogen consumption
- a helium/water heat exchanger to remove the heat dissipated from the helium blower.

The warm temperature high speed helium blower has been completely designed by Criotec Impianti for this project in order to optimize the performance for the requested operating conditions.

Instrumentation for the measurement of the main working parameters allows to monitor and regulate the operating condition of the TCU in terms of temperature and flow rate. The TCUs will be operated at a pressure in the range 6.5÷9.5 barg and with a temperature range of 82÷400K on the helium side.

The TCUs design data are as follow: design pressure of 9 barg + external vacuum on the helium side and a design temperature of -205/+130°C since it can work also with saturated liquid nitrogen at sub-atmospheric pressure.

The three larger TCUs, two used for the temperature control on the thermal shrouds and one for the temperature control of the baseplate, have a rated nominal helium flow rate of 250 g/s while the smaller TCU, used for the temperature control of the UUT TGSE, has a rated nominal helium flow rate of 40 g/s. Each TCU is equipped with a He buffer to compensate for the volume variation of the gas from the cold to hot working conditions.

These TCUs are a valid solution for the thermal control of TVC when conditioning down to cryogenic temperature is requested together with a good spatial uniformity. Depending on the specific application the units can be scaled in the range of the nominal flow rate of the two sizes developed or can achieve higher thermal powers installing multiple units in a modular way.

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