

XVC Facility Description

General

The XVC test facility was developed for the exposure of components to thermal vacuum conditions, representing space environment in open space and sun exposure. Furthermore, the thermal vacuum bakeout and the thermal vacuum cycling of flight hardware are key applications for this test facility.

The vacuum chamber is made of stainless steel and offers an inner space of approx. 1,500 mm in width, 1,500 mm in height, and a length of 2,000 mm (volume: approx. 4,5 m³). Therefore, the test facility is suitable for testing larger sub-elements and components.

Temperature Control

The temperature of the hardware under investigation is adjusted by means of temperature-controlled copper plate(s) mounted inside the vacuum chamber, and by additional wall/door/ceiling heaters. Process plates are heated electrically, the cooling is performed by liquid nitrogen (LN2: T = -196 °C). General specifications of this plate are:

- Process Plate dimensions: 1,300x600 mm²
 - 3 plates available in current configuration
 - Total Process Plate Area 1,800 x 1,300 mm²
- 60x100 mm grid of M6 threads for sample fixation
- Heating rate up to 3-4 K/min
- Maximum operating temperature 200 °C
- Cooling rate up to 3-4 K/min
- Minimum operating temperature -185 °C in vacuum
- Various copper shields for improved thermal homogeneity available
- Up to 6 heating/cooling plates may be used with 3 plates mounted on the lower side, acting as sample support plates, and 3 smaller plates of 1,000x700 mm each on the upper side for providing a thermal shroud
- A total process plate area of up to 1,300x1,800 mm² is available.
- Heater Panels:
 - Covering all side walls, doors, and ceiling of the chamber
 - Electrically heated, max. operating temperature ~180 °C

Environment

The XVC test rig is attached to a clean room classified as ISO7. The front door is inside the clean room, the external equipment like vacuum pumps, cooling systems, TQCM, and data processing systems, are located outside. Figure 1 shows overview images of the XVC test rig, and Figure 2 shows the inner of the XVC from the clean room side, including the loading mechanism.

For specific purposes, access to the XVC from the visible clean environment is possible.

If required, an additional cleanroom tent may be installed for providing an environment suitable for highly sensitive flight hardware.



Chamber Flanges and Interfaces

To allow the connection of measurement devices for the characterisation of the test object (e.g. thermocouples, Si-diode sensors, motors, etc.) and to connect the cooling and heating devices the chamber is equipped with the following flanges:

- 1xCF160 flanges on the front door placed in the clean room
- 2xCF40, 5xCF63, and 2xCF100 flange on the back side
- 3xCF100 on the left side and 3xCF40 on the right side with view from cleanroom
- 2xCF200 and 4xCF40 on top
- 4xCF100 and 1xCF200 on the bottom

There are several electrical interfaces available at AAC:

- Signal feedthroughs RS-232, male/male, not crossed-out
 - Several 25 pin, 15 pin, and 9 pin feedthroughs available
 - Crossed-out airside cables available
 - Gender changers available
- Power feedthroughs for up to 10A per pin, various connectors available
- High Power feedthroughs for 60A
- RF Signal feedthroughs

Other feedthroughs

- Fluid feedthroughs, e.g. for fluid cooling systems
- LN2 feedthroughs for operating process plates, cold plate, etc.

Other interfaces are available on request.

Vacuum Generation and Control

A vacuum pressure of 10^{-7} mbar can be achieved, depending on outgassing of the device under test. Alternatively, it is possible to perform tests in defined gas atmosphere (e.g. 100 mbar N₂). Various non-corrosive gases at pressures below ambient can be used for the testing.

The following equipment is used to maintain and control the pressure:

- Rotary vane pump Adixen ACP 40 M (oil-free multistage Roots pump)
- Turbo pump Pfeiffer Hi Pace 2300 U (1800 l/s); second pumping unit possible
- Full range vacuum gauge Pfeiffer PKR 251
- Pressure control TPG362/Pfeiffer RVC300/EVR 116 valve/APR250 gauge

All pressure measurement cells are calibrated by manufacturer. Additional calibration is available only on request.

Temperature Measurement and Control

To achieve the required temperature on the hardware, 16 Eurotherm temperature controllers are available. They allow the definition of complex temperature profiles which can be completed automatically. The temperature of the hardware under test is measured by 32 Type K shielded thermocouples, 0.5 mm diameter, at several positions inside the XVC. For each setup all thermosensors are calibrated using an Ametek CTC-650 calibration furnace (calibrated by manufacturer) according to AAC's internal procedure AA-18.

Installation of other temperature sensors, e.g., Pt100 or Pt1000, is feasible.

The following equipment is currently used:

- 17x Eurotherm 2416
 - 3x for process plates (heating/cooling)
 - 3x for ceiling heaters (currently heating only, but capable of heating/cooling)
 - 6x for side wall heaters (3 left, 3 right hand side)
 - 4x for door heaters (each 2 front/back door)
 - 1x for cold plate,
- Up to 32 thermocouples type K (\varnothing 0.5 mm), regularly calibrated in house
- On request: 20 PT100, \varnothing 2.0 mm, measurement by Keithley 2700 Multimeter

Additional Support Equipment

- For trapping condensable matter, a cold plate with approximately 400x200 mm size is installed. The standard operation temperature is -50 °C; the minimum operation temperature is -180 °C.
- To assess the amount of material evaporated from the sample during the thermal vacuum test a TQCM (Temperature-controlled **Q**uartz **C**rystal **M**icrobalance) with 6 MHz quartz is used. The temperature is typically kept at -20 °C, but may be operated at lower temperatures, too.
- For RGA analysis (**R**esidual **G**as **A**nalysis) a quadrupole mass spectrometer can be attached to the chamber.
- For specific applications the measurement of electrical properties (e.g. electrical resistivity, voltage, current) is required. For this purpose, a Keithley 2700 Multimeter equipped with Keithley 7700 multiplexer is available. Up to 20 channels may be read out simultaneously. This device is also used to read the PT100 temperature sensors (if installed).
- To test the performance of moving parts (e.g. potentiometers, slip rings ...) under space environment, a drive train can be mounted on the XVC chamber. It is equipped with servo or stepper motors and different torque gauges.
- All devices listed above are controlled by PC. The TherESA software to control all devices and to record all parameters has been developed at AAC.
- For thermal cycling of components, additional LN2 cooled/electrically heated panels, dimensions 1,000x700 mm, may be installed. Customer specific shrouds are being designed and manufactured in house

Cleaning Procedure

The step-by-step procedures, how tests are performed in the XVC rig can be found in the according test specifications and in the test procedures available at AAC. However, one common step to prepare the test rig for the tests is the cleaning procedure. For all operations performed in the clean room, cleanroom smocks and cleanroom snoods should be worn during cleaning operations and for handling the hardware.

The chamber and all installed support equipment are being wiped with IPA using non-linting cleanroom tissues. In specific cases, other permitted solvents may be used, too. The cleanliness is tested and documented by performing wiping tests: The tissue is soaked with IPA and the inner side of the CF flange where the water-cooled turbo-molecular pump is mounted, is wiped. The tissue is put into a sample bag and the sample bag is stored in plastic sheets together with the project's process slip. Also a contamination protocol is stored.

Chamber Bakeout

The amount of molecular organic contaminants (MOC) is most efficiently reduced by chamber bake-out under vacuum. This is typically done in two stages:

- Facility Cleaning Bake-Out:
Standard temperature 165 °C on main process plates and wall/door/ceiling heater panels
Duration at least 24 hours
Target value $\ll 1 \times 10^{-5}$ mbar
- Blank Bake-Out
Temperature and duration depending on customer specification
Duration typically 72h
Target vacuum $< 1 \times 10^{-5}$ mbar (typically $< 3 \times 10^{-6}$ mbar)
Optional: TQCM monitoring
Installation of MOC / PFO samples (to be provided by customer)

Contact

For any questions, please contact

Aerospace & Advanced Composites
Viktor-Kaplan-Strasse 2 Building F
A-2700 Wiener Neustadt / AUSTRIA
Phone: +43 2622 90550 0
Mail: office@aac-research.at



Figure 1: Overview of XVC Thermal Vacuum Chamber:
right: view from clean room, left: view from test center.



*Figure 2: View inside XVC Thermal Vacuum Chamber:
left – small component installed; right – parts under Al foil insulation*



*Figure 3: Bake-Out Jig, e.g., for MLI Bakeout:
left – outside chamber during loading; right – inside XVC before closing main door*

Table of Equipment

To summarise the information given above, Table 1 lists the equipment used at the XVC test rig.

Table 1: List of Equipment for XVC Test Rig

Equipment	Type	Ser.Nr	Remark
Coarse Vacuum Pump	Adixen ACP40 M	AC685160	Oil-free multi-stage Roots pump
Turbo -Molecular Pump	Pfeiffer Hi Pace 2300 U	16956780	Second unit may be installed on request for specific applications
Standard Vacuum Gauge	Pfeiffer PKR 251	44696637	Full range gauge
Backup Vacuum Gauge	Pfeiffer PKR 251	44751564	Full range gauge
Vacuum Monitor	Pfeiffer TPG 362	44872386	Controller for PKR gauges
Vacuum Controller	Pfeiffer RVC300	PFI 00792	Controller for EVR116/APR280
Temperature Controllers for Base Plates	Eurotherm 2416	PL1921001285 PL1921001286 PL1921001288	
Cold Plate Temperature	Eurotherm 2416	PL1921001287	
Temperature Controllers for Heater Panels	Eurotherm 2416		In total 13 units
Sample Temperature Measurement	Type K thermocouples, Inconel, dia 0.5 mm	n/a	Standard: 32 pcs installed More sensors available on request
Sample Temperature Signal Converters	Datexel DAT3018 RS232	n/a	4 units for 8 sensors each More units can be added on request
Multimeter	Keithley 2700	4045974	with Keithley 7700 multiplexer 20 channels available
PT100 thermo-elements	OMEGA Thinfilm RTD Element F3105	n/a	
TQCM Controller	Colnatec EON-LT	ELT-300378	
TQCM Sensor Unit	BeamTec / McVac Inc. Twin Sensor Head Model MV-700-009S	n/a	6 MHz crystal
Calibration furnace	Ametek CTC-650 B RS232	620568-00905	
RGA	ThermoScientific Smart IQ+	1703-01-182-3	Quadrupol mass spectrometer; range 0-200 amu

List of Consumables

The used consumables are listed in Table 2 below:

Table 2: Consumables for use in the XVC Test Rig

Consumable	Quality	Vendor / Article ID#
<u>Cleaning fluids:</u> <ul style="list-style-type: none"> • 2-Propanol (mostly used) • Acetone • Ethanol • n-Pentane 	AnalaR NORMAPUR ACS/REAG.PE/REAG.USP IR grade TechniSolv reinst AnalaR NORMAPUR zur Analyse	VWR Chemicals Roth Lactane VWR Chemicals VWR Chemicals
<u>Cleaning Tissue:</u> <ul style="list-style-type: none"> • Cleanroom Wipes 	Spec-Wipe® 4	VWR Collection Art.-No. 115-0036
<u>Mounting samples / thermo-sensors:</u> <ul style="list-style-type: none"> • Kapton tape 	ECSS-Q-ST-70-02C passed (each new batch tested at AAC)	RS-Components Art.-No. 436-2778
<u>Purging / Venting:</u> <ul style="list-style-type: none"> • Nitrogen (standard) • Argon (on request) • Carbon dioxide (on request) 	Grade 5.0, 99.999% Grade 5.0, 99.999% Grade 3.0, 99.9%	Messer Austria
<u>Thermal Shielding / Homogenisation:</u> <ul style="list-style-type: none"> • Aluminium foil • Multi-layer isolation (up to +150 °C) 	OTS / various suppliers MLI Coolcat 2	RUAG Space Austria

Please note: Other consumables may be used if agreed on between AAC and Customer.