range from a minimum of 150 K to a maximum of 473 K. The temperature at 48 different locations within the chamber is monitored by use of thermocouples. Temperature is controlled mainly by balancing (1) the inward leakage of heat from ambient temperature against (2) the removal of heat by circulation of a mixture of warm gaseous nitrogen and cold vaporized liquid nitrogen through a cooling shroud inside the chamber. The rates of flow of the warm and cold nitrogen are monitored by flowmeters and regulated by controllable valves. Additional heating is provided by tape heaters outside the chamber and additional cooling by a liquid-nitrogen cold plate.

Following initial evacuation, the chamber is backfilled with an atmospheric gas mixture (e.g., CO₂ with small amounts of N₂, Ar, O₂, and H₂O to simulate the Martian atmosphere) at low pressure [typically between 6 and 9 milibars (between 600 and 900 Pa) for the Martian atmosphere]. Thereafter, pressure is brought to and maintained at the required value by use of a feedback control system that balances the rate of flow of atmospheric gas into the system against the rates of leakage and of vacuum pumping. The feedback control system includes a pressure sensor and a gas-feed throttle valve.

The composition of the gas is monitored by use of a separately operated residual-gas analyzer, the output of which is sent to the automated control system. A mass flow controller maintains the desired relative concentrations of the gases in the atmospheric gas mixture.

A programmable logic controller (PLC) is the heart of the automated control system. The PLC accepts inputs from a manual control panel, capacitance manometers, flowmeters, pressure controllers, and thermocouples. The PLC provides outputs to indicators on the manual control panel, and to the vacuum, heating, cooling, pressure, and gas-composition systems described above. Numerous outputs are sent to a graphical user interface (GUI) that features “soft” controls and indicators that emulate those of the manual control panel with the addition of elaborate graphical management capabilities. The GUI notifies the PLC when it is ready to accept or provide information relative to the control process. Optionally, the operation of the MEC can be controlled by use of the manual control panel alone, or partly by use of the manual control panel and partly by use of the GUI. This option affords flexibility for manually performing tests while maintaining safe operation by use of automatic control.

Inquiries concerning rights for the commercial use of this invention should be addressed to the Patent Counsel, Johnson Space Center, (281) 483-0837. Refer to MSC-22899.