CLAIMS

1. A system for sampling air at multiple locations in a controlled environment comprising:

a plurality of air sampling devices, each configured to draw a volume of air within a controlled environment;

a plurality of vacuum connections, each configured to receive the volume of air from one of the plurality of air sampling devices;

a plurality of flow sensors, each configured to sense a mass flow rate of the volume of air received by one of the vacuum connections;

a server, connected to a network, that provides a graphical user interface that is accessible by a network-connected computing device, the graphical user interface providing functionality for a user to specify one or more setpoints indicative of a desired mass flow rate at one or more of the air sampling devices; and

a plurality of flow control valves, each of the plurality of flow control valves configured to initiate an air sampling cycle at one of the air sampling devices and control the mass flow rate of the volume of air received by the corresponding vacuum connection in response to the desired mass flow rate specified by the user via the graphical user interface.

2. The system of claim 1, wherein the graphical user interface further provides functionality for the user to abort an air sampling cycle at the one or more of the air sampling devices.

3. The system of claim 1, wherein the network is the internet.

4. The system of claim 1, wherein the server is configured to authenticate the user and determine whether the user is permitted to issue commands.

5. The system of claim 1, further comprising:

a database that stores data indicative of the mass flow rates of the volumes of air received by the plurality of vacuum connections to an external device via a network connection,

wherein the server outputs the data indicative of the mass flow rates to the network-connected computing device for display via the graphical user interface.

6. The system of claim 1, wherein the system is configured to:

determine whether the mass flow rate of the volume of air received by one or more of the vacuum connections deviates from the desired flow rate beyond acceptable alarm limits; and

output an alarm to the user via the graphical user interface of the network-connected computing device in response to a determination that the mass flow rate deviates from the desired flow rate beyond the acceptable alarm limit.

7. The system of claim 1, further comprising:

a plurality of actuators, each of the plurality of actuators configured to open and close one of the flow control valves; and

a programmable logic controller (PLC) configured to:

receive the setpoints indicative of the desired mass flow rates at each of the one or more air sampling devices;

receive measured flow rates from the plurality of flow sensors indicative of the mass flow rates of each of the vacuum connections;

determine errors indicative of the differences between the measured flow rates and the setpoints; and

output control signals to the plurality of actuators to reduce the differences between the measured flow rates and the setpoints.

8. The system of claim 7, wherein:

the plurality of air sampling devices comprises a first air sampling device and a second air sampling device;

the plurality of vacuum connections comprises a first vacuum connection configured to receive the volume of air from the first air sampling device and a second vacuum connection configured to receive the volume of air from the second air sampling device, the first and second vacuum connections in flow communication with a vacuum pump via a manifold; and

the PLC is configured to reduce the difference between the measured flow rate of the volume of air received by the first vacuum connection and the setpoint indicative of the desired mass flow rate at the first air sampling device caused by a change in the volume of air through the second vacuum connection.

9. The system of claim 7, wherein the each of the flow control valves are configured to adjust such that a change in position of the flow control valve is:

proportional to the size of the difference between the set point and the measured flow rate of the vacuum connection corresponding to the respective flow control valve; or

proportional to a rate of change of the difference between the set point and the measured flow rate of the vacuum connection corresponding to the respective flow control valve.

10. The system of claim 1, further comprising:

a vacuum pump configured to draw the volume of air from the plurality of air sampling devices,

wherein the system is configured to disconnect power to the vacuum pump in response to a determination that the mass flow rate of the volume of air received by one of the vacuum connections in flow communication to the vacuum pump is below a predetermined threshold.

11. A method for sampling air at multiple locations in a controlled environment, the method comprising:

drawing, by a plurality of air sampling devices, volumes of air from within a controlled environment;

receiving, by a plurality of vacuum connections, the volumes of air from each of the plurality of air sampling devices;

sensing, by a plurality of flow sensors, the mass flow rates of the volumes of air received by each of the vacuum connections;

providing a graphical user interface, by a server via a network, for display on a network-connected computing device;

receiving, from a user via the graphical user interface, one or more setpoints indicative of a desired mass flow rate at one or more of the air sampling devices;

initiating an air sampling cycle at one of the air sampling devices; and

controlling, by one of a plurality of flow control valves, the mass flow rate of the volume of air received by the corresponding vacuum connection in response to the desired mass flow rate specified by the user via the graphical user interface.

12. The method of claim 11, further comprising:

receiving, from the user via the graphical user interface, an additional command to abort an air sampling cycle at the one or more of the air sampling devices; and

aborting an air sampling cycle in response to the command received from the user via the graphical user interface.

13. The method of claim 11, wherein the network is the internet.

14. The method of claim 11, further comprising:

authenticating the user; and

determining whether the user is permitted to issue commands.

15. The method of claim 11, further comprising:

storing data indicative of the mass flow rates of the volumes of air received by the plurality of vacuum connections to an external device via a network connection; and

outputting the data indicative of the mass flow rates to the network-connected computing device for display via the graphical user interface.

16. The method of claim 11, further comprising:

determining whether the mass flow rate of the volume of air received by one or more of the vacuum connections deviates from the desired flow rate beyond acceptable alarm limits; and

outputting an alarm to the user via the graphical user interface of the network-connected computing device in response to a determination that the mass flow rate deviates from the desired flow rate beyond the acceptable alarm limit.

17. The method of claim 11, wherein controlling the mass flow rates comprises:

receiving, from a plurality of flow sensors, measured flow rates indicative of the mass flow rates of each of the vacuum connections;

determining errors indicative of the differences between the measured flow rates and the setpoints; and

outputting control signals to the plurality of flow control valves to reduce the differences between the measured flow rates and the setpoints.

18. The method of claim 17, wherein the difference between the setpoint indicative of the desired mass flow rate at a first air sampling device and the measured flow rate of the volume of air received by a first vacuum connection receiving the volume of air from the first air sampling device is caused by a change in the volume of air through a second vacuum connection that is in flow communication with the first vacuum connection via a manifold.

19. The method of claim 17, further comprising:

adjusting one or more of the flow control valves such that a change in position of the flow control valve is:

proportional to the size of the difference between the set point and the measured flow rate of the vacuum connection corresponding to the respective flow control valve; or

proportional to a rate of change of the difference between the set point and the measured flow rate of the vacuum connection corresponding to the respective flow control valve.

20. The method of claim 11, further comprising:

drawing the volume of air from the plurality of air sampling devices by a vacuum pump;

determining that the mass flow rate of the volume of air received by one of the vacuum connections in flow communication to the vacuum pump is below a predetermined threshold; and

disconnecting power to the vacuum pump in response to the determination that the mass flow rate of the volume of air received by one of the vacuum connections in flow communication to the vacuum pump is below the predetermined threshold.