CLAIMS

What is claimed is:

1. An apparatus comprising:

an active flow control system including one or more inlets and one or more outlets, wherein:

a first outlet of the one or more outlets is configured to be fluidly coupled to an inlet of a mini-environment, and

a first inlet of the one or more inlets is configured to be coupled to an outlet of the mini-environment; and

wherein the active flow control system includes one or more flow control configurations, wherein each flow control configuration corresponds to a flow control modes, the one or more flow configurations including a configuration corresponding to a sampling mode comprising:

injecting a neutral fluid from the first outlet into the inlet of the mini-environment, and

directing a mixed fluid exiting through the outlet of the mini-environment to the first inlet of the active flow control system, the mixed fluid being a combination of the neutral fluid and the fluid that was in the mini-environment before injecting the neutral fluid into the mini-environment.

2. A load port unit (LPU) comprising:

an active flow control system including one or more inlets and one or more outlets, wherein:

a first outlet of the one or more outlets is configured to be fluidly coupled to an inlet of a mini-environment, and

a first inlet of the one or more inlets is configured to be coupled to an outlet of the mini-environment; and

wherein the active flow control system includes one or more flow control configurations, wherein each flow control configuration corresponds to a flow control modes, the one or more flow configurations including a configuration corresponding to a sampling mode comprising:

injecting a neutral fluid from the first outlet into the inlet of the mini-environment, and

directing a mixed fluid exiting through the outlet of the mini-environment to the first inlet of the active flow control system, the mixed fluid being a combination of the neutral fluid and the fluid that was in the mini-environment before injecting the neutral fluid into the mini-environment; and

a contamination analysis system integrated in the LPU and fluidly coupled to a second outlet of the one or more outlets of the active flow control system.

3. The apparatus of claim 1 or claim 2 wherein the active flow control system can be coupled to one or multiple mini-environments; or

wherein the active flow control system is an add-on adaptor module coupled to an existing simple flow control system.

4. The apparatus of claim 1 or claim 2, further comprising a control center communicatively coupled to the active flow control system, wherein the control center can transmit instructions to the active flow control system that, when executed, cause the active flow control system to execute one or more of the flow control modes.

5. The apparatus of claim 4 insofar to be dependent on claim 1, further comprising a contamination analysis system adapted to be communicatively coupled to the control center and fluidly coupled to a second outlet of the one or more outlets of the active flow control system.

6. The apparatus of claim 4 insofar to be dependent on claim 2, wherein the contamination analysis system is communicatively coupled to the control center.

7. The apparatus of claim 5 or claim 6 wherein the contamination analysis system is also communicatively coupled directly to the active flow control system; or

wherein the instructions include instructions that, when executed, cause the active flow control system to direct the mixed fluid to the contamination analysis system; or

wherein the contamination analysis system can be coupled to one or multiple active flow control systems.

8. The apparatus of claim 5 or claim 6 wherein the one or more flow control modes include:

a check mode in which the active flow control system checks itself for contamination,

a clean mode in which the active flow control system cleans itself of contamination, and

a purge mode in which the active flow control system purges contamination from the mini-environment.

9. The apparatus of claim 8 wherein the active flow control system is fluidly coupled to an existing load port unit with an existing purge function, wherein the purge mode uses or supplements or replaces the purge function of the existing load port unit.

10. The apparatus of claim 8 wherein the active flow control system adds the sampling mode, the clean mode, and the check mode to the existing purge function, wherein the sampling mode and the purge mode run concurrently for at least an initial part of the purge mode.

11. The apparatus of claim 8 wherein, in addition to cleaning the active flow control system, the clean mode cleans the contamination analysis system.

12. The apparatus of claim 8 wherein each flow control mode is programmable, wherein each flow control mode can be programmed to use a flow rate profile and the flow profile can be adjustable.

13. The apparatus of claim 12 wherein different flow rate profiles can be used in different flow control modes for specific mini-environments, wherein one or more new flow control modes can be added to existing flow control modes.

14. The apparatus of claim 4 wherein the instructions include instructions that, when executed, cause the active flow control system to execute an operation, the operation including multiple flow control modes selected from the one or more flow control modes and executed in a sequence.

15. The apparatus of claim 14 wherein the sequence of flow control modes in the operation is changeable and programmable; or

wherein the sequence of flow control modes can include multiple instances of any flow control mode.

16. The apparatus of claim 1 or claim 2 wherein the first inlet and the first outlet of the active flow control system are fluidly coupled to a load port of a process module.

17. The apparatus of claim 16 wherein a clean mode, a check mode, and a sampling mode are added to an existing load port’s purge mode.