Molten Salt Glovebox Design

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BACKGROUND

Molten salts are employed in different generation 4 advanced reactor designs, as well as in solar energy production plants because of their attractive thermal properties, which allow them to operate at much higher temperatures than conventional power generation system coolants, such as water [1]. These higher operating temperatures allow for more efficient power production.

Gloveboxes are used in laboratories to help contain contaminants and other potentially harmful substances from becoming a biological hazard. They are of specific use to molten salt researchers because they can be pressure controlled, inert environments, helping to keep salts pure and humans safe [2].

METHODOLOGY

Many challenges arise when working with molten salts within a confined space, like a glovebox, because molten salts require high operating temperatures which create the need for specific safety considerations.

This poster highlights the specific top level functional requirements relevant to mitigating the challenges associated with molten salt experimentation within a glovebox system.

When considering the design of this system, the safety of the experimenter and maintaining the integrity of the experiment were of top priority. Therefore, the top-level functional requirements which need to be met for both safety, and experimental integrity were outlined, see Table 1.

FUNCTIONAL REQUIREMENTS

Table 1., right, lists the top-level functional requirements, and their supporting requirements MUST be met in a glovebox design for use with molten salts containing beryllium. How these functional requirements are implemented in the system is illustrated in Figure 1, upper right.

The containment functional requirement ensures the prevention of cross contamination between the system atmosphere and the atmosphere outside the system. Figure 2, right, shows the flow diagram of how the system is isolated and every entry/ exit point is HEPA filtered to ensure this requirement is met.

TABLE 1. Beryllium glovebox functional requirements.

#	Top Level Functional Requirement	Supporting Requirements
FR1	Containment	• Prevent air ingress • Prevent contamination • Over/ Under pressure relief valves • Filters (HEPA, etc.) • Feed-throughs • Antechambers
FR2	Safety	• Thermal switches • Flow switches (loss of coolant) • Toxic gas monitoring (for long-duration electrolysis) • Gas Scrubbers
FR3	Temperature control	• Heat exchanger sizing • Chiller selection/specification • Water source
FR4	Interface requirements and options for future features	• Feedthroughs • Electrical • Gas • Water

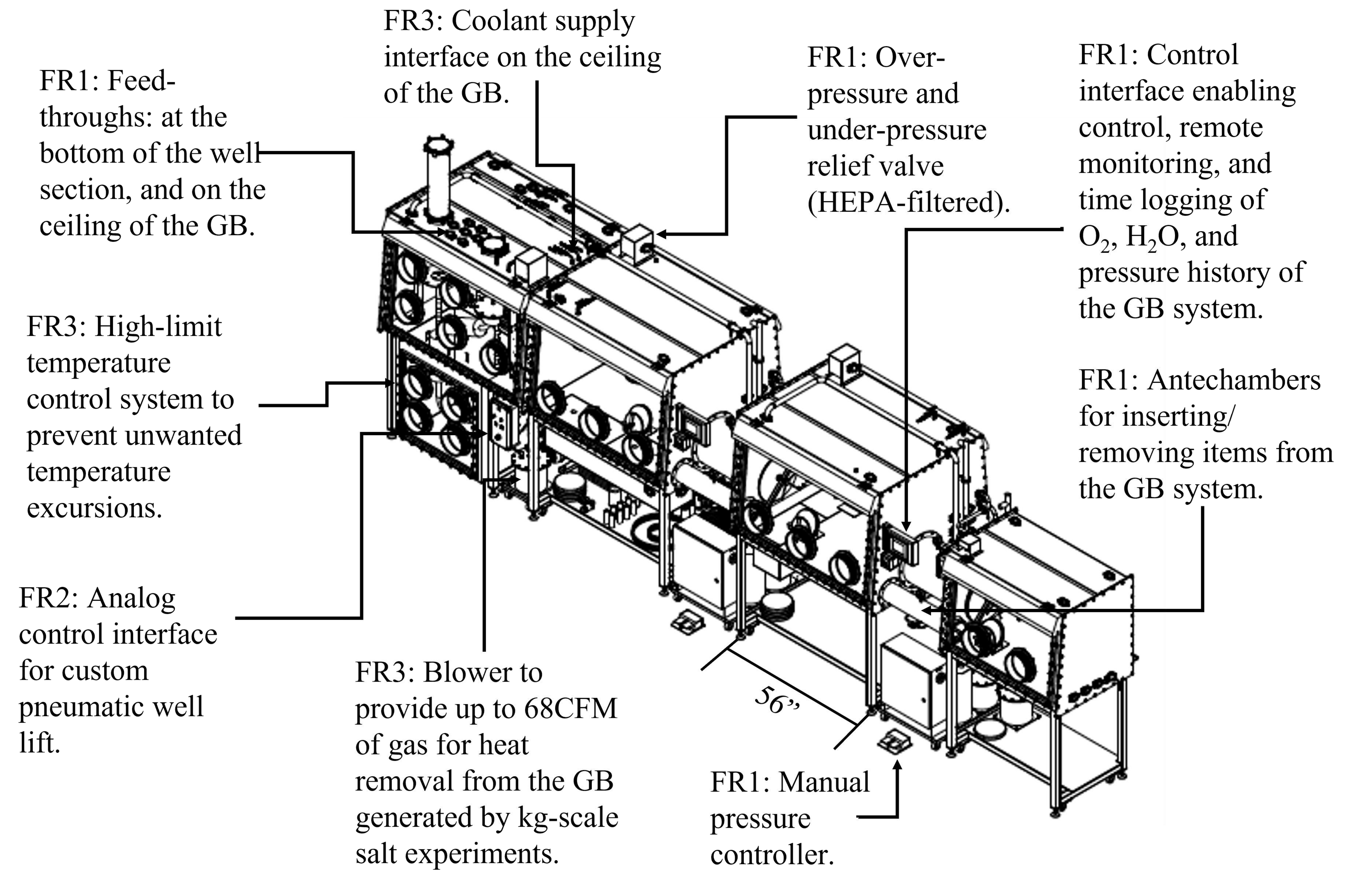

Fig. 1. Glovebox (GB) train used for high temperature experiments with molten salts containing beryllium, illustrating functional requirements (FR) for the GB train.

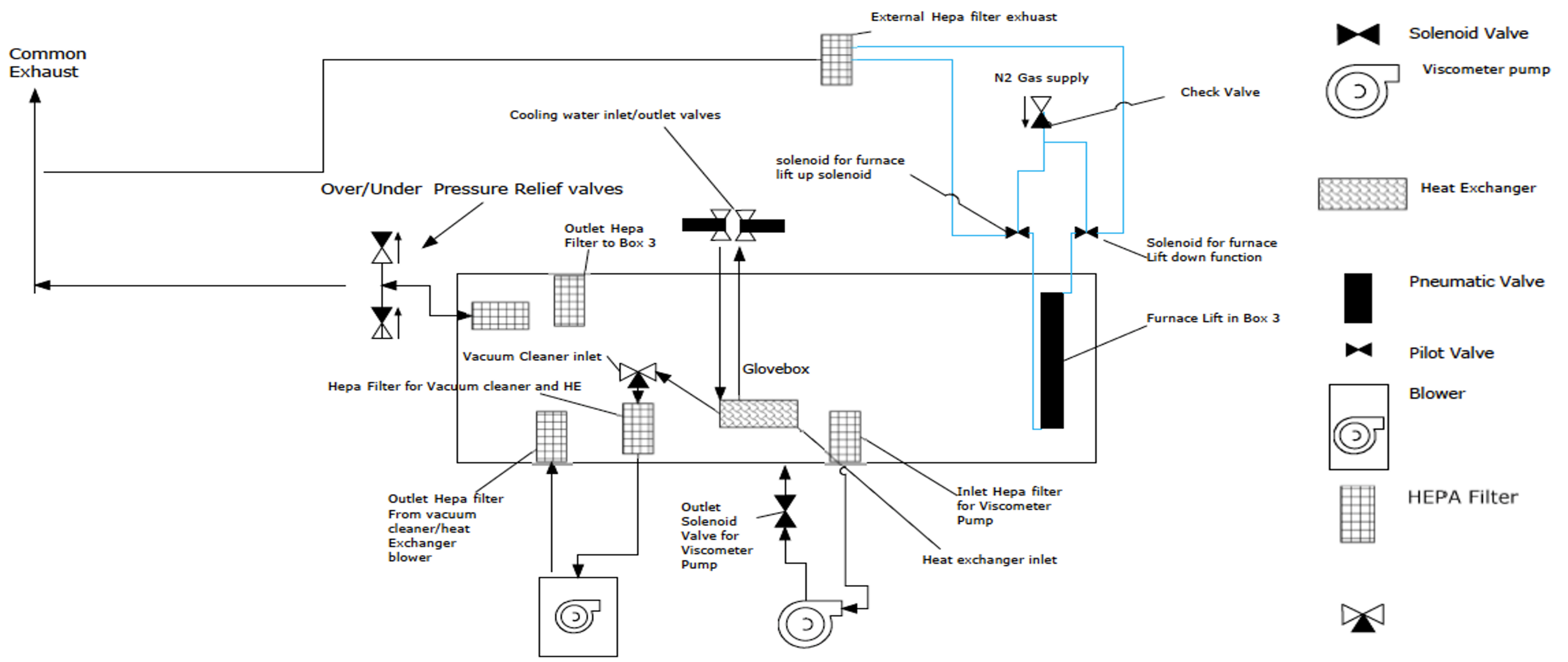

Fig. 2. Flow diagram illustrating principles of containment: all exit lines from the GB are HEPA filtered, including antechamber refill lines and over/under pressure relief valves, which prevent glove failure, further mitigating containment breaches.

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