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PALLET INSERTION GLOVEBOX/HOOD CONTROL LADDER DIAGRAM

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SUMMARY

The pallet insertion glovebox/hood (G/H) is a special confinement space that will be designed to allow for insertion of pallets into the Stacker/Retriever (S/R) area. The S/R is a large inert vault that is kept at negative 1" w.c. relative to the atmosphere and is used for the safe storage of special nuclear material. The S/R system uses a vehicle to move the special nuclear material that are placed on the pallets from the storage bins to input/output (I/O) stations and vice versa. As the name suggest the I/O stations are used to place the material into the S/R vault or to remove material from the S/R vault.

The pallets are specially designed structures that will hold certain numbers of the material containers in a safe configuration. To store additional material containers, there is a need to insert additional pallets in the S/R vault. Due to the presence of radioactive contamination and the fact that the vault must be kept at a negative pressure at all times, one of the several I/O stations will be modified so that pallets could be inserted into the S/R vault.

The ventilation system for the S/R area is a dedicated system that recirculates nitrogen with less than 5% oxygen by volume throughout the area while exhausting small potion of the nitrogen to keep the S/R at negative 1" w.c. relative to the atmosphere. The rooms surrounding the G/H and the S/R area are maintained at negative of 0.3" w.c. relative to the outside atmosphere.

Both the G/H and the control system for the G/H will be designed such that the confinement requirements of the S/R and the G/H system will not be jeopardized. A ladder diagram will be developed to illustrate the control system.

GLOVEBOX/HOOD DESCRIPTION

The G/H will be a special box that will consist of two guillotine doors. The G/H will be connected to one of the I/O stations. When the outer guillotine door is closed the G/H will be considered a glovebox and will meet the confinement requirements of a glovebox i.e., negative pressure and air change rate requirements. When the outer door is open the box will be considered a special hood that will meet the face velocity requirements typically employed in laboratory hoods. Appendix section of the report includes a schematic of the G/H confinement.

When both doors are closed and the G/H is considered as a glovebox, minimum flow rate is dictated either by the minimum air change rate requirements or it is the rate required to avoid pressure fluctuation outside the allowable operating pressure if glove ports are used. When the outer door is open, the exhaust air flow rate must be such that the average air velocity across the door opening is 100 ft/min. To obtain the desired flow rates and to keep the G/H at a negative pressure (when the inner door is closed), the G/H will be connected to the I/O station with an exhaust duct work. Nitrogen will be supplied to the G/H so that the flow requirements can be met when inner door is open or when the both doors are closed.

The design of the G/H will include the following control features:

- The doors will be controlled by key switch to prevent unauthorized operation.
- Only one door can be open at the same time.
- Both the outer and inner doors will be equipped with a light curtain to stop the guillotine doors if an obstruction is detected while the doors are being closed.
- Fully closed and fully open limit switches will be installed for both doors.
- When the outer door is opened, the flow of nitrogen will be stopped. This will ensure that nitrogen will not displace the oxygen in the room at the vicinity of the G/H.
- The flow of the nitrogen will also be stopped if the photohelic gauge monitoring the G/H pressure detects G/H to room differential pressure is less than 0.25" w.c. (G/H shall be kept minimum of 0.25" w.c. negative relative to the room). Note that this is an expected condition when the outer door is open.
- Two flow rates are to be supplied to the G/H. The low flow rate will be used when outer door is closed, and when the inner door is open the flow rate will be increased to the high flow rate to prevent the outer chamber becoming contaminated.

- When the outer door is being opened or closed the exhaust valve will modulate to keep the air face velocity across the door opening at approximately 100 ft/min. A vertical door opening sensor will measure the vertical travel of the door using a potentiometer. The output signal will be sent to the exhaust valve controller.
The exhaust flow will be modulated by a special venturi valve that is manufactured by Phoenix Controls Corporation. The Venturi valve uses the concept of a force acting on a cone in a given size orifice to measure air flow. The cone is attached to a shaft via special spring and can move back and forth relative to the shaft. The movement of the shaft itself however is controlled by the valve controller. In its simplest form the Phoenix Venturi valve can be considered a constant volume device whose volume is set by the position of the valve shaft. In addition, to the flow measurement the Phoenix Venturi valve uses the flow measurement force to create a fast acting pressure independent controller by moving the cone relative to the shaft in order to maintain the constant volume set point. The Phoenix Venturi valve and its control system is stand alone unit. Therefore, the ladder diagram will not depict any of the control scheme for the valve.

OPERATING REQUIREMENTS

The G/H and its control system shall be designed to comply with Department of Energy (DOE) orders and follow the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE) or other industry standards as applicable.

During the pallet insertion and when the outer guillotine door is in open position, the G/H must be considered as a special hood that will comply with ANSI/ASHRAE 110 and ANSI/NIHA Z9.5 standards. The face velocity across the door opening shall be designed for 100 ft/min regardless of the door opening position.

When both doors are closed the G/H shall be considered as a glovebox. The control system design shall maintain the negative pressure of the G/H at about 0.7" w.c. negative relative to the room and at no time shall this pressure drop below 0.25" w.c. negative relative to the room. The flow rate shall be such that G/H will have at least 5 Air Changes per Hour (ACH). However, care must be given to the fact at the low flow rates operation of the gloves (insertion of gloves into the glovebox) will cause pressure fluctuation that may be outside the permissible limits.

SEQUENCE OF OPERATION

HOOD CONFIGURATION MODE (OUTER DOOR IS OPEN)

To start the pallet insertion, the pallet is raised by a scissor jack to align it with the outer door. The outer door is opened and pallet is pushed inside the G/H. During the opening, closing and when the door is fully open the face velocity across the opening will be kept at about 100 ft/min by modulating the exhaust valve. During this mode of operation the nitrogen supply to the box is stopped.

GLOVEBOX CONFIGURATION MODE (BOTH DOORS ARE CLOSED)

After insertion of the pallet, the outer door will be slowly closed. After the door is completely closed the nitrogen supply valve will start to open so that the minimum air flow requirement could be met. No operation of the gloves should take place until the low flow nitrogen supply valve is fully open. This will eliminate the pressure fluctuation. In this mode of operation the exhaust valve is at the minimum set position opening (exhaust valve is not modulated).

INNER DOOR IS OPEN

After the low flow to the G/H is established, the inner door may be slowly opened. In conjunction with the door opening the high flow nitrogen supply valve will also start to open. After the inner door is fully open then the pallet could be pushed to the I/O station.

After the pallet is placed in the I/O station the inner door could be closed. Pallet can then be placed into the S/R vault by the existing hoist, lift and trolley system.

THE LADDER DIAGRAM

The Ladder Diagram is a graphic schematic of the control scheme for the G/H control system. The Ladder Diagram for this G/H will include momentary contact push-buttons for manual opening and closing of the inner and outer guillotine doors. The limit switches are arranged such that the doors will stop at the fully open and close position automatically. The status of the doors will be presented by eight (four for each door) lights that will indicate "DOOR OPENING", "DOOR CLOSING", "DOOR OPENED" and "DOOR CLOSED".

The following is a list of abbreviation used within the Ladder Diagram:

CNSV	Common nitrogen supply solenoid valve
ES	Emergency stop
HNSV	High nitrogen flow solenoid valve
ID	Inner door
IDCLS	Inner door close limit switch
IDCSV	Inner door closing solenoid valve
IDOLS	Inner door open limit switch
IDOSV	Inner door opening solenoid valve
LNSV	Low nitrogen flow solenoid valve
OD	Outer door
ODCLS	Outer door close limit switch
ODCSV	Outer door closing solenoid valve
ODOLS	Outer door open limit switch
ODOSV	Outer door opening solenoid valve

The Ladder Diagram is included in the Appendix section of the report. As shown on the Ladder Diagram, the outer door will be opened by pushing the momentary push-button. This will energize the CR1 coil which in turn will close the holding contacts CR1. The door will start opening since the ODOSV is energized. During the door opening the "OUTER DOOR OPENING" light will be ON. When the door is completely opened the C2 contacts of the ODOLS will open and will stop the outer door at its open position. At this time the C1 contacts off of the ODOLS will close and the "OUTER DOOR OPENED" light will go ON.

To close the outer door, the OD CLOSE button shall be momentary pushed. This will energize the CR2 coil which in turn will close the holding contacts CR2. The door will start closing since the ODCSV is energized. When the door is completely closed the C1 contacts of the ODCLS will open and will stop the door operation (the ODCSV will be de-energized). During this operation the "OUTER DOOR CLOSING" light will be ON. The "OUTER DOOR CLOSED" light will turn ON when the C2 contacts of the ODCLS is closed.

The normally closed contacts CR5 and CR6 are included to avoid simultaneous opening and closing operation of the same door, and to include a safety feature that will enable the operator to close door even if the door is opening. If the OD CLOSE button is pushed while the outer door is opening, the CR5 will open and will stop the door opening operation and will start closing the door. With this safety feature the door closing will override the door opening operation at all times.

The opening and closing of the inner door will be the same as of the outer door as shown on the Ladder Diagram.

The common nitrogen supply solenoid valve will be a normally closed (NC) valve. This valve will be activated when the pressure inside the G/H is more negative than -0.25" w.c. relative to the room.

The low flow solenoid valve will be activated only when the C2 contacts of the ODCLS is closed. The high flow solenoid valve however, will be activated when the C1 contacts of IDCLS is closed (inner door is opening, closing or fully open) and C2 contacts of ODCLS is closed (the outer door is closed). Two needle valves are included to the down-stream of the high and low flow solenoid valves, these valves will be used to adjust the response time of the air operated valves in the field so that pressure fluctuation is minimized during the closing and opening of the valves.

APPENDIX

GLOVEBOX/HOOD CONFINEMENT SCHEMATIC

NO SCALE