Maintenance and Upgradation of RML Hot Cell Ventilation System

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1.0 Introduction

Hot cell ventilation system of RML is in service for more than 30 years. So far, the ventilation system has performed well without any interruptions. During the service life of the system, a few instances which warranted breakdown maintenance of the components of hot cell inert gas recirculation system was encountered. In such situations, the maintenance of the radioactive ventilation system was completed successfully without any spread of contamination to the surroundings. To enhance the level of safety and reliability, few modifications are also being undertaken to upgrade the hot cell ventilation system. This paper describes the experience gained during the maintenance of the systems and the safety measures employed during such campaigns.

2.0 Maintenance of venti blower in IGRS loop of hot cell ventilation system

Inert enviroment hot cells of RML have high purity low moisture nitrogen gas inside. An inert gas recirculation systen (IGRS) is used for the ventilation of RML hot cells. IGRS draws radio-actively contaminated hot nitrogen gas from the hot cells and supplies back to the hot cells after purification and cooling. IGRS together with inert hot cells forms a closed loop called IGRS loop. IGRS consists of an activated charcoal bed for the removal of organic/inorganic impurities, HEPA filter for the removal fine radio-active particles and cooling coil for the removal of heat from the nitrogen, and a hermetically sealed venti blower for the circulation of nitrogen through IGRS loop. For redundancy, in the loop 100% standby capacity is provided for the components such as HEPA filter, cooling coil and venti blower. The venti blower can develop 400mm water column(WC) pressure and can achieve a recirculation rate of 4000Nm3/hr (Fig.1). A variable frequency drive is used to control the speed of venti blower and thereby the flow through the loop. In two instances which were seperated by about a decade, abnormal noises were heard from the venti blower #1. Investigations revealed that the root cause for both the incidents were collection of condensate water in the bottom portion of the blower casing.

Over the years, leak paths like minor cracks were formed in the gaskets and weld joints of IGRS loop. This has resuted in the ingress of ambient air into the IGRS loop which lead to the increase of moisture content in the nitrogen. In the IGRS loop, brine solution is circulated through cooling coil for the removal of heat and moisture from nitrogen gas. A part of the water codensed in the cooling coil carried by nitrogen to the venti blower casing and got accumulated there. Another reason suspected for the incident was the blocking of water flow path in the cooling coil casing. Over the years, the amount of water collected in the blower casing became significant. After isolating the blower, with health physics surveillance, maintenance activities have carried out to remove the water from the blower casing. Fig. 2 shows water stagnated inside the casing of the blower. Execution of the maintenance work involved preparation of operating procedure and obtaining safety clearances and safe disposal of accumulated water. Repair crew with proper personal protective equipment (PPE) carried out the maintenace work. After removal of the condensate water, trial runs were performed to obtain clearance for regular operation of the venti blower.

Figure 1. Venti blower of IGRS Loop

Figure 2. Presence of water inside the blower casing

To avoid the recurrence of such collection of condensate water in the blower casing, a new "U" drop set up has been incorporated in the IGRS loop drain line as shown in Fig. 3. The flow of water through the tube is visible in this set up. It will ensure complete draining of water from the cooling coil casing and thereby prevents movement of moisture to blower casing. The set up is detachable for maintenance.

3.0 Upgradation of hot cell ventilation system

3.1 Fast vent line:

RML hot cells are maintained at negative pressures between -20mm to -30mm WC with respect to operating area by feed and bleed arrangement. To enhance the margin available in the bleed rate to cope with any abnormal rise in pressure due to any malfunction or leakage into the cells, it was proposed to modify the automated bleed system by replacing the existing 25NB vent lines with a new higher size vent line.

A high flow rate automatic electro-pneumatic fast vent line made of stainless steel AISI 304L, schedule 40, 50NB pipe size has been designed. It will be installed between the hot cell exhaust header (after charcoal bed) and exhaust system-III header to replace the two automatic 25NB vent lines. There is a parallel circuit with hand operated globe valve for manual adjustment of gas flow rate. The pipe spool for fast vent line is shown in Fig.4.

Figure 3. New PVC drain line in IGRS loop

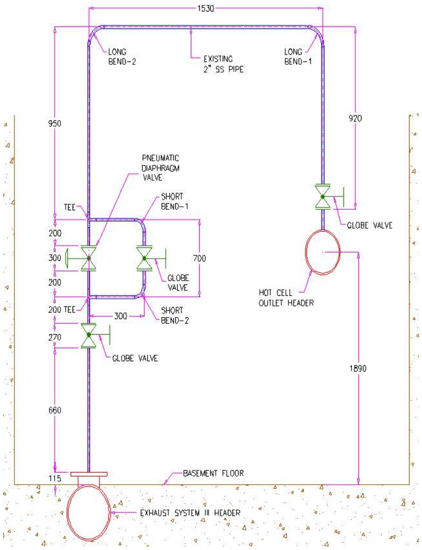

Figure 4. A fast vent line for Hot Cells

3.2 Emergency Backup Evacuation System (EBES)

During changeover of exhaust blower or simultaneous failures of class III and class IV power supply or malfunctioning of equipments, restoration of supply and exhaust blowers will take around 3 minutes. To prevent the possibility of hot cell pressure equalizing with that of operating area pressure, an emergency backup evacuation system with a dedicated blower and control system has been proposed.

The failure of any exhaust system blower will cause automatic closing of its inlet and outlet dampers and electro-pneumatic valves in the automatic nitrogen venting lines of inert environment hot cells. Even though this action will isolate the hot cells, the leakage of air from surroundings through leak paths could equalize the pressure inside them with that of surroundings. Therefore, a new automatic emergency backup evacuation system as shown in Fig. 5 which draws power from a newly installed class II power supply is proposed to maintain pressure inside the hot cells in the aforementioned emergency situations

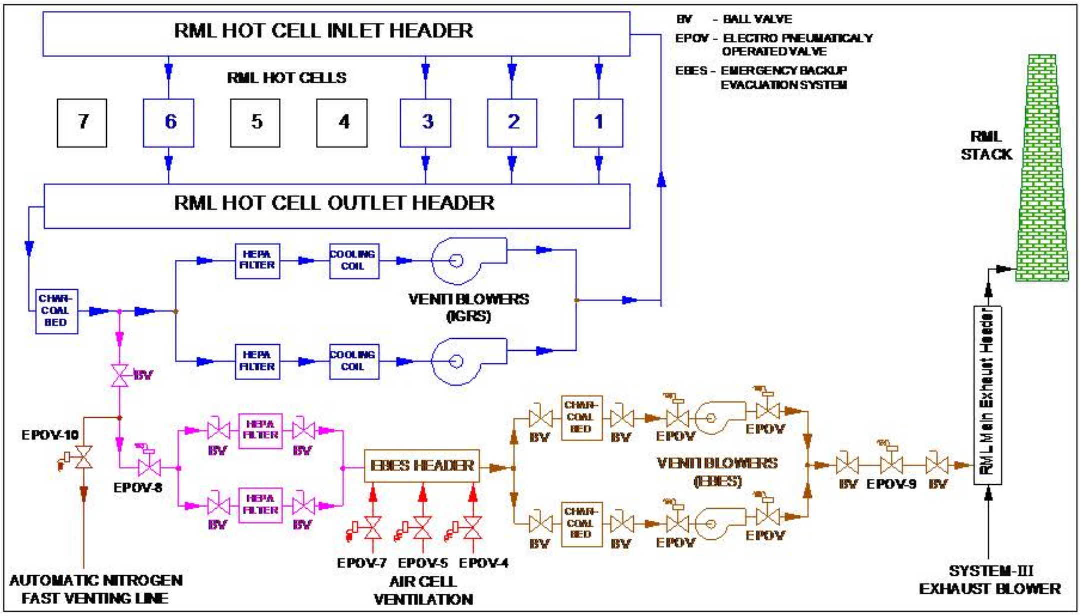

Figure 5. Emergency Backup Evacuation System for Hot Cells

The proposed emergency backup evacuation system consists of a hermitically sealed blower, EBES header, manual and automatic valves, HEPA filters, associated piping, uninterrupted power supply (class-II) and a PLC system. Blower is provided in EBES with 100% standby capacity. In case of failure of exhaust system III blower, EBES will automatically operate and evacuate the IGRS loop to the pre-set value of pressure.

4.0 Conclusion :

Periodic upkeep and upgradation of Ventilation system is crucial for safe operation of radiological facilities. During the last three decades of operation of RML hot cells, the ventilation system of the hot cells and associated facilities have been continuously upgraded and maintained.