DEVELOPMENT OF PNEUMATIC GATE VALVE CONTROLLER FOR INDUS-2

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Abstract

The first active component which isolates the ring vacuum and beamline vacuum and subject to face the full heat load of the radiation is the all metal vacuum gate valve (GV0). It needs to be properly interlocked from any accidental exposure to synchrotron radiation (SR) beam. We have developed gate valve controller for the safe operation of the vacuum valve based on relay logic.

INTRODUCTION

The 2.5 GeV electron storage ring Indus-2 is a hard X-ray Synchrotron Radiation (SR) source with a critical wavelength $2A^0$. The front-end is an interface between the beamline and the storage ring. It consists of various mechanical and vacuum components [1] that provide (1) vacuum safety to storage ring from beamline side (2) protects the beamline and front-end components from damage by synchrotron radiation, absorbs the heat load (3) absorbs the ionizing radiation and (4) defines the beam. Figure-1 shows the schematic layout of a typical front-end assembly. As the front end vacuum system is directly connected to the storage ring, its vacuum should be of the same order as the ultra-high vacuum (UHV) in the storage ring. The vacuum at the front end is below $5x10^{-9}$mbar. Reliable operation of the front end system is thus very important, since any malfunction would immediately interrupt the operation of the ring.

All metal vacuum gate valve (GV0) is the first component of a front-end which isolates ring vacuum and beamline vacuum. These valves are not water cooled and remain open when beam is circulating in Indus-2. These valves will be closed only during the maintenance of the storage ring or beamline. In the first phase 8 such gate valves were installed. Their opening and closing were done manually. In second phase 19 such gate valves were installed but all were pneumatic. Since the new installed valves are pneumatic, any failure due to air pressure or power will expose them to beam. These valves can't take heat load of the beam and will get damaged. A four channel controller is developed for their safe operation.

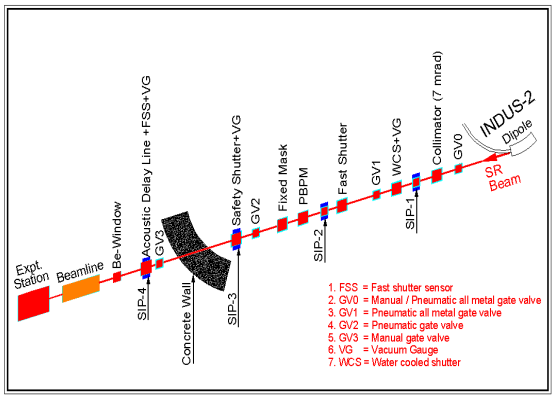

Figure 1: Schematic layout of the front-end components.

CIRCUIT DESCRIPTION

The gate valve GV-0 used in the front-end is VAT make which uses Lucifer solenoids [2] for their operation. These solenoid valves are fitted with a pilot seat, controlled by the solenoid coil and a diaphragm which closes the main orifice of the valve, using the air pressure for operation. The required air pressure for their operation is 4-6 bars. When the solenoid is energized by supplying the required DC bias voltage by the controller, the core opens the pilot seat to allow the pressure on the upper part of the diaphragm to flow to the outlet of the valve body. Thus a pressure imbalance is created on the diaphragm, raising it and fully opening the valve orifice. When the solenoid is de- energized, the pilot seat closes and the pressure passing through an "equalizer" hole is restored above the diaphragm, thus closing the valve. The ladder diagram of the controller is as shown in figure 2.

The controller ensures (1) sufficient air pressure for the operation (2) vacuum from the storage ring side and beamline side are within the defined limit before executing OPEN command.

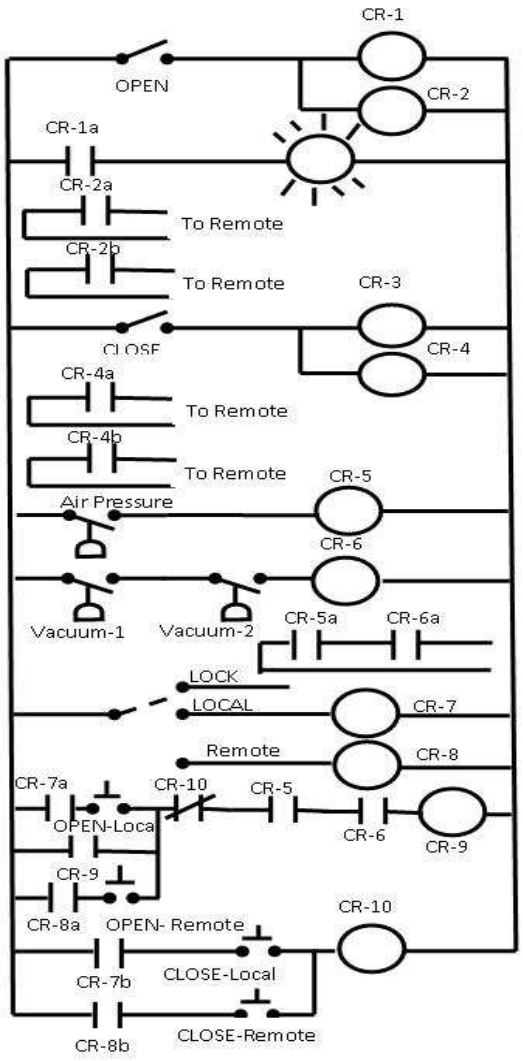

Figure 2: Ladder Diagram of the controller.

A relay logic scheme is deployed to control the valve operation. There are three modes of operation in the controller (1) Local (2) Remote and (3) Lock, each one selected by a key switch on the front panel. In local mode all operation of the valves is controlled from front panel of the controller, no remote commands will be executed. Front panel displays the status of valve and the respective interlock. All the control and status signals are provided to main control room for remote operation via remote connectors of respective valves on the rear side of the controller. During the shutdown period GV-0 should remain closed. For that "Lock" mode has been provided, it ensures that the valves are closed and no command would be executed. The front panel of the controller is as shown in figure 3.

For the fail-safe operation, valves used are 'energised to open', so that even if mains power fails or the control cable is cut/open by any means, valve should be closed immediately. The 'Not open' status of valve has been interlocked with machine control system. If 'Not Open' status is true, an electron beam dump signal is generated by machine control system. One controller can operate four pneumatic valves. Five such controllers are installed in Instrumentation gallery of Indus-2 ring, which are remotely operated from Indus control room [2].

CONCLUSION

The gate valve controllers are operational since May 2009 without any failure. During the shutdown or the maintenance period these valves are closed remotely. The performance of the controller is at par for which it was designed.

ACKNOWLEDGEMENT

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REFRENCES

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