AUTOMATIC FIRE WATER SYSTEM FOR ACCELERATOR COMPLEX, RRCAT INDORE

B.K.Rawlani, D.Arzare, S.Ahlawat, R.P.Agrawal, A.Pundalik, S.S.Kulkarni, A.M. Kekre
Raja Ramanna Centre for Advanced Technology, Indore

INTRODUCTION

The accelerator complex at RRCAT comprises Synchrotron Radiation Sources (SRS) Indus–I (450MeV) & Indus-II (2.5GeV), DC Accelerator, Microtron and Linear accelerator with their associated buildings and subsystems like magnet power supplies, RF Power supplies, Ultra high vacuum, low conductivity water plant, centralised AC plant, electrical substation etc. The subject automatic water fire fighting facility has been set up to feed the fire hydrant network lines in the accelerator complex.

REQUIREMENT

As per the safety norms, it is essential to have a fire fighting system in place, before commissioning of an accelerator system. The pressurised water hydrants at critical locations are very useful for fire fighting for the number of adjacent buildings. The actual fire area can be accessed with flexible hose pipe connected to these hydrants. Automatically controlled high pressure water lines are also required by high velocity water spray, foam monitor, water cum foam monitor, foam sprinkler and water sprinkler systems for fire fighting. As per the TAC (tariff advisory committee) guidelines minimum 3.5 kg line pressure (open hydrants) is stipulated for water fire fighting system.

The accelerator facilities spread over a wide area are critical; their human occupancy is generally high. In case of a fire any delay/ mal-operation caused by human error may create dangerous situation. In view of stringencies of fast and correct operation and limited human resources automation of the pressurised fire water system was envisaged.

SCHEME

The fire hydrant network consists of 150mm dia. pipeline with a number of wet riser type hydrants maintained ready for at standing pressure (closed hydrants) between 6 to 7 Kg/Cm^2 by the PLC based control system. The system broadly consists of the following.

a. Main pump: 150 HP; 273 cum; 88MWC electric motor driven centrifugal pump.

b. Standby diesel pump: 217 HP; 273cum capacity centrifugal pump.

c. Jockey Pumps: Two 15 HP; 88 MWC electric motor-driven centrifugal pumps to compensate for any line leakages.

d. Hydro Pneumatic Tank: 8000 litres with 2:1 Water: Air column for keeping the water line pressurised at 7kg/sq. cm. The purpose of HP tank is to provide compressible medium in pressurised line and minimise the frequency of operation of jokey pumps on occurrence of leakages

e. Compressors: Two 10 kg / sq. cm capacity; 5HP electric motor driven reciprocating compressors for maintain air pressure in HP tank.

f. Suction Line: 300 mm ERW MS.

g. Discharge line: 250mm ERW MS header, feeding 4.7km long, partially underground line with wet riser type hydrants.

All pumps are connected between suction and discharge headers with NRVs at their discharge end.

AUTOMATIC CONTROL SYSTEM

It controls the operating sequence of mechanical equipments to keep the fire hydrant system ready for use. The control and protection scheme used for main pump motor (150 HP) is as shown below in fig. 1. A similar scheme has been used for jockey pumps too.

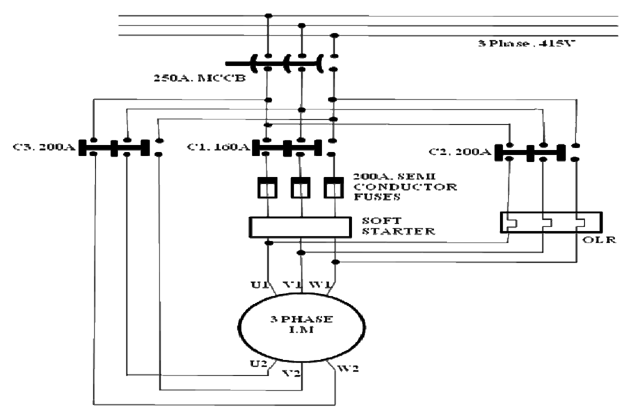


Fig. 1

The control system includes various differential pressure switches, Solenoid valves, resistive water level gauges, smart pressure transmitters, Soft starters [2], and programmable logic controller (PLC) etc. The PLC has 24 digital outputs, 25 inputs and one analog (4-20mA) input for smart pressure transmitter. The transmitter can interact over HART protocol and linear output. The cycle time of the PLC with loaded program is about 0.4 sec. whole control logic has been implemented by PLC program. Hardwired logic is also available, by which, the whole system can be operated manually during maintenance etc.

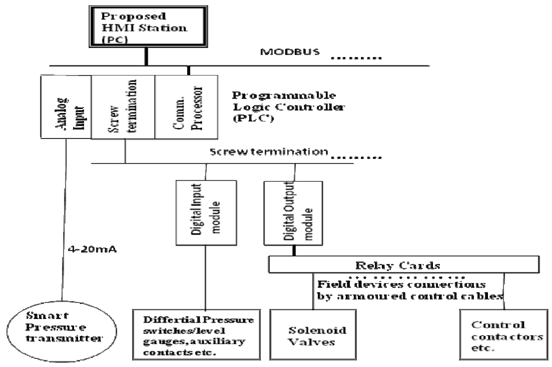
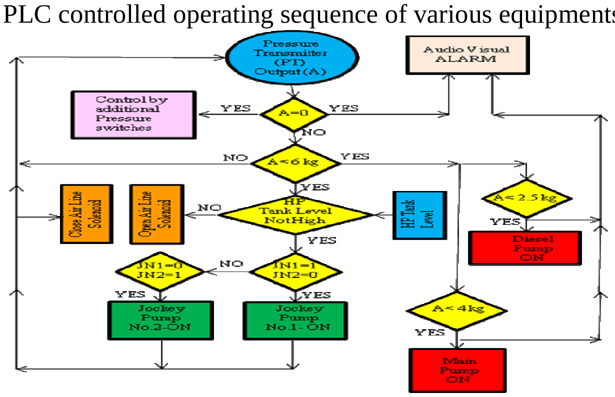


Fig. 2

For operational reliability DOL starters have been provided as standby for the main pump and jockey pumps. Architecture of the system is shown in fig. 2.In addition to this a repeater panel has been provided in the Main Fire Station building, for manual supervision of the system. It has all audio-visual annunciations and some important control features. UPS have been provided for reliability of power supply to all control panels.

OPERATING SEQUENCE

A simplified flow chart shown in fig. 3 describes the PLC controlled operating sequence of various equipments.



JN1=1 -- Jockey Pump No. 1 counter high.
JN2=0 -- Jockey Pump No. 2 counter low.

Fig.3

a. Jockey pumps (1+1 redundancy) operation has been configured alternatively in swapping mode and based on line pressure (6 Kg /cm2) & HP tank low water level set point. As soon as water level in HP tank reaches at high level Jokey pumps are turned off irrespective of the line pressure.

b. If say Jockey pump no. 1 fails to start with on soft starter, then after a the pre-set time interval of 5esc, the PLC will generate a alarm and try for the operation of same pump with redundant DOL starter. Even if now pump no. 1 does not start, PLC will give command to start the pump no. 2 with second soft starter, and on failure of soft starter, again command is given for DOL start as in case of pump no. 1. Before the jockey pump starts, the solenoid valve provided on the compressed air line is closed to avoid the water entry into compressor tank. If required, HP tank air leakage is compensated by opening the solenoid valve on compressed air line. The Jockey pumps shall remain off (after achieving top level) during air supply to the HP tank.

c. In case pressure drops to a preset value 4 Kg/Cm sq., the electrically operated main pump (150HP) shall start with soft starter. When fire fighting is over the pump shall not turn off automatically and requires manual intervention for ensuring that fire fighting is over.

d. In case pressure drops to pre-set value of 2.5 Kg/Cm Sq., the diesel pump (217HP standby) shall start. This also needs human intervention to turn off.

e. Compressors are operating independently.

Condition Monitoring of the system has been achieved through monitoring of field parameters like water reservoir line strainer choking, water level in reservoirs, diesel engine fuel level etc. with facility of audio visual alarm at local and remote panels. Status of the field equipments including pumps and compressors are obtained through contactors/relays etc. Live zero communication scheme has been adopted for the pressure transmitter for clear indication of wire break.

IMPORTANT FEATURES

1. Use of soft starter minimises the line stress and hence damages due to water hammer, assures desired performance even during bad voltage conditions and also does not stress the power system through heavy inrush currents.

2. Hydro Pneumatic tank makes the system energy efficient through reducing the operating frequency of jockey pumps and subsequently reducing the mechanical wear and tear.

3. Reliability has been achieved through redundancy incorporated for the core components in the system.

4. Inside Closed Delta configuration has been used for the switchgear pertaining to the motor starters. This has resulted in lower ratings and thus cost of the components.

CONCLUSION

The various set points were optimised during commissioning trials by opening the fire line hydrants at different locations. System has been operating satisfactorily for almost last three years.

REFERENCES

[1] Fire protection manual – TAC.

[2] Soft starter handbook- ABB.

[3] Substation SCADA for SRF INDUS - An overview (INPAC 2005) - B.K.Rawlani[#], R. K. Agrawal, A.D.Pundalik, A.M.Kekre, Centre for Advanced Technology, Indore.

[4] ABB PLC manual.

[5] Atomic Energy factory rules.