Operation of Cryogenic Facility in e-way at Tata Institute of Fundamental Research, Mumbai, India.

K V Srinivasan
Low Temperature Facility, Tata Institute of Fundamental research, Dr. Homi Bhabha Road, Colaba, Mumbai 400 005, India.
E-mail: kvsrini@tifr.res.in

Abstract. In an attempt towards the development of modern, model and paperless cryogenic facility, the Low Temperature Facility of Tata Institute of Fundamental Research, at Mumbai, India; carried out many automation works using programmable logic controller (PLC) and other modern electronic tools, with the objective of bringing the entire plant operation to your palm whenever and wherever you are. Efficiency in the plant operation by keeping a watch on the plant healthiness, advance indication about the possible plant problem by means of pre-warning alarms, so that the remedial action can be taken well prior to the actual failure affects the plant operation, reduction in plant down time were achieved by the automation works. Large size in our cryogen production, controlling the complicated helium liquefier, meeting the uninterrupted supply of cryogen to the users on “any time availability basis”, safety in handling cryogens and high pressure gas, effective usage of limited skilled manpower etc., all these requirements call for the definite need of modern electronic gears and gadgets. This paper will describe in details about the automation works carried out at our cryogenic facility at TIFR.

1. Introduction
Cryogenics (Low Temperature) facility at TIFR, Mumbai provide the support of liquid helium, liquid nitrogen and other cryogenic support services to the users of the above institute for the past five decades (since 1962). Our facility presently operates and maintains the Linde make, L280 Helium Liquefier and STIRLIN-8 liquid nitrogen plant. Operating and maintaining the above cryogenic plants is a challenging job and much more demanding is to operate it efficiently. We at TIFR proposed a method, which is modern, simple, easy to use, but powerful tool ensuring adequate measures for minimal plant down time operation, particularly with the restricted work force availability.

2. Objective
The primary objective is to development of model cryogenic facility with the full-fledged computer controlled automation and a paperless facility. This will ensure us to keep a close watch on the plant, so that the possible failures, which can stop the plant operation, can be diagnosed much before it
reaches the plant. The area of automation includes Plant operation, Helium gas management, cryogen dispensation, report generation, alters through Email & SMS, safety & security etc.

2.1. Methodology
Using the programmable logic controller (PLC) devices, field signal transmitters along with suitable software program, the process is graphically monitored and controlled on a real time basis. The schematic flow path of the automation is given as Fig. 1.

2.1.1. About the PLC
We used the Siemens make, S7-400 PLC system, for hooking the field signal received from the transmitters, This SIEMENS - PLC system comprises of CPU 412.2, signal modules (analog and digital input/output cards) Data from the PLC to the remote monitoring PC is with the CP 5613-MPI/PCI adapter card using profi-BUS cable and adapter.

2.1.2. Software: Siemens, Symantec Step 7 software was used to read the analog signal received from the field and execute the logics in the CPU of PLC. Siemens, WinCC software was used for the graphical visualization. Visual Basic, C+ was also used for developing the other purposes.

2.1.3. Parameters to monitor: More than 60 parameters are monitored through the field transmitters and the typical parameters measured are mostly pressure, helium gas purity, moisture content, utility pressure, utility temperature, gas balloon level, mass flow, oxygen content etc at various locations in the plant room. The location and the parameters to be monitored are chosen in such a way that the data is useful in diagnosing the plant problem and scope for rectifying the problem well before it affects the plant operation. Most of the transmitters are connected with the indicators, which are fitted in the control panel for easy access and as a backup module in case of unforeseen software bugs. The photo of the control panel and its cabling is given in Fig. 2.

2.1.4. Monitoring and control: It was necessary to view all the data in a suitable format so that the entire process is simple and easily understandable. Using WinCC visualization software, the status of the parameters are monitored and displayed in the form of graphical visualization in a remote PC. During the start up phase, we have used the above software only for the purpose of monitoring. Later, we added many alarms, trip values supported with the auto logging of tags.

2.1.5. Graphical visualization: A graphical user interface screen was developed with appropriate navigation button, which is password controlled for security purpose. This graphical window was
created in WinCC software with the concerned tags of the field signals received from the transducers is displayed at appropriate locations in the graphical window. The screenshot of the graphical window for the Helium gas management is given in Figure 3.

2.1.6. Alarm and control: In order to trigger an alarm, it is necessary to define the set limits of the parameters both high and low level. A separate screen was developed to enable or disable every parameter. The screenshot of the alarm enabling screen is given as Fig. 4.

2.1.7. Data logging and reporting: Report generation is essential for analyzing the data, particularly in case of any abnormality and its influence on the other plant parameters to nail down the problem precisely. We have made a provision in the software, for automatic data logging every 10 minutes. All the hooked parameters are stored in an excel format, which is easy & simple for data retrieval and analyzing. The system will also generate the shift report every eight hours through online printer. The typical shift report extract is shown in Fig. 5.

2.1.8. Alarm messages through SMS and e-mail: For easy access and to bring the plant operation much closer, the information need to be passed on to operating staff on an online basis. This could be possible only if the status information are sent by SMS via mobile phone and also through email. For this, a wireless USB modem with mobile SIM card is connected to the monitoring PC. The information from the OPC server of WinCC is picked for sending SMS and email to the registered mobile numbers and email id’s. More than 30 critical parameters are presently connected to the email and SMS.

2.1.9. E-logging: With the above automation and the report generation, our operating staff had stopped using the traditional logbook for the past few years, however, there are few information like communicating note of operator in shift duties, any visual abnormality in the facility, safety related information’s are usually recorded in the logbook or duty report. We decided to automate even the above part of the operation, by introducing the E-Logbook facility. All these information are sent as email & SMS along with storing in the database. The screenshot of the E-logbook is reproduced in Fig. 6.
2.1.10. Online Helium gas accounting: The helium gas inventory needs special attention and it is necessary to keep a close watch on the helium gas loss, as it is very expensive. For this purpose, the helium gas meters with the digital pulse counter are procured, so that the PLC can utilize the digital pulse for calculating the quantity of gas received in a given point of time. With the accumulated gas volume of the balloon and the pressure rise in the storage gas cylinder, the gas is accounted for loss or gain. The online loss/gain report is generated with alarm for any abnormal helium gas loss. Even the compressor hour meters are automated, so that gas accounting can be crosschecked with the compressors hours of operation and its capacity.

2.1.11. Status and Performance: At present, the hooked parameters are being monitored along with all possible alarm triggering in case any deviation of parameters from their allowed limits. At present, no control loop is added in the program and is planned in future. The present format of data logging and report generation gives us sufficient room for analyzing the problems in a better way. By connecting the PC to the Internet and using the remote PC connectivity software such as Symantec PC Anywhere / Team viewer, it has become possible to view the plant parameters at any point of time and from anywhere in the world, thus the system is truly remote operated.

2.1.12. Future upgradation: As a part of upgradation, it is proposed to have more control and alarms, operation of chiller pumps through PLC, alarms for indication the forthcoming preventive maintenance, valve status if any are being planned in the future.

3. Summary
With the suitable hardware and a PLC, it is possible to develop this auto logging system in a much simple way so that operation of the plant becomes much easier, comfortable and highly effective, even with the less available workforce. We have developed this method in such a way that, this can be extended to the any of the cryogenic facility. Thus, the results and the benefits of this concept are highly advantageous for the effective helium liquefier operation.

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