The Hall B Cable Gas Detection System

Software Development Overview

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Introduction

Roughly, over two hundred miles of cables are installed in Hall B - one of the three experimental areas at Jefferson Lab. Such an amount of cable poses a fire-hazard. To alert personnel of an impending fire, an alarm system that detects gases emanating from overheated cables, has been designed, developed and installed. This paper presents the configuration of the hardware, the software and the *modus operandi* of the alarm system.

Hardware Configuration

The main components of the alarm system are a programmable logic controller (PLC), an infrared spectrometer (IRS) and a personal computer (PC)(see Appendix A for details of each component).

The PLC consists of communications modules, analog input modules, remote input-output modules (I/O)[♆] and a micro-controller module. Via the I/O modules, the PLC remotely operates the pumps and electro-mechanical control-valves, which are attached to the plastic tubes through which gas samples are extracted from the hall.

The spectrometer screens the acquired gas samples for hydrocarbons (CH) and carbon monoxide (CO) levels and sends the results of the analysis to the PLC via the PC.

The PC, which is connected to the PLC and the IRS by serial cables controls the operations of the PLC, acquires the data from the IRS and writes it to a spreadsheet (Figure #1).

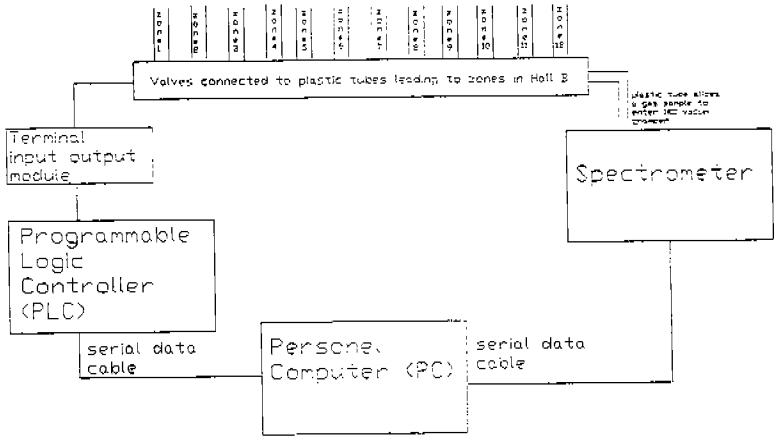


Figure 1 Block diagram of the cable gas detection system showing the components and the communication links. Spare tubes leading to the hall are not shown.

[♆] I/O modules have been used to reduce the amount of cables at the PLC micro-controller.

Software Configuration

Programs *Main Interface.vi*, *Spectrometer.vi* and *PLC.vi*, were developed in *LabView* to control the operations of the PLC and the IRS. Software used by the PLC and the IRS are *MODLINK* and *OMNIC* respectively (Figure #2).

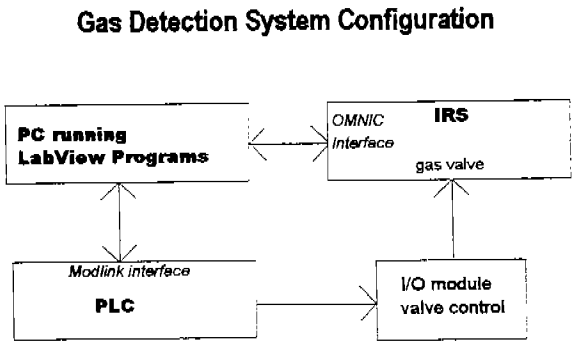
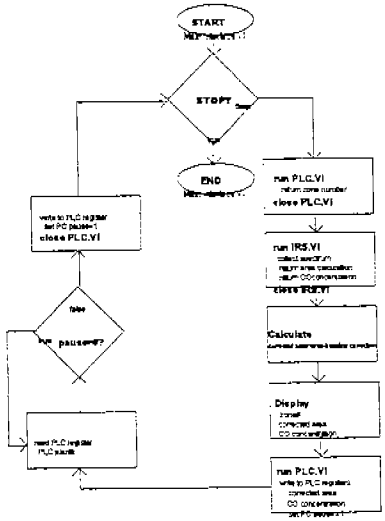


Figure 2. The PC controls the operation of the IRS through OMNIC software. Modlink software enables the PC to access the PLC input/output registers. Valves are controlled by the PLC.

Data flow and the execution order of *PLC.vi* and *Spectrometer.vi* are controlled by *Main Interface.vi*, which also reads the zone number of the open valve and associates it with a location in the hall. Figure #3 outlines the operational flow of the LabView program *Main Interface.vi*. Table #1 lists the zone numbers and associated locations.



Hall B air sample zones

Zone #	Location
1	Space Frame Level 3 North
2	Space Frame Level 3 South
3	Space Frame Level 2 North
4	Space Frame Level 2 South
5	Space Frame Level 1 North
6	Space Frame Level 1 South
7	Tagger Electronics
8	Side Carriage Level 1 South
9	Side Carriage Level 1 North
10	Forward Carriage Level 1
11	Forward Carriage Level 0
12	Forward Carriage Level 2

Table 1. Hall B zones currently being monitored by the gas detection system. Zones 13-20 are spares at this time.

Once *PLC.vi* is activated, it initiates a dynamic data exchange (DDE) conversation with *MODLINK*, which once established enables *PLC.vi* to monitor register 400002 in the PLC. Register 400002 is set to 1 ("PLC ready" state) by the PLC after it opens a valve to extract a sample of gas from a given location in the hall.

As soon as register 400002 is set to 1, *PLC.vi* sets register 400003 (also resides in the PLC) to 0 to indicate "PC busy" and proceeds to collect IRS data by running the program *Spectrometer.vi*, which operates the IRS. When executed, *Spectrometer.vi* initiates a DDE conversation with *OMNIC* and commands specific to *OMNIC* request the IRS to begin collecting the spectrum of the current gas sample.

Immediately after register 400003 is set to 1, which indicates the "PC ready" state the PLC resets register 400002 to 0 to indicate "PLC busy" and switches over to a new valve. The operation continues in this fashion. Table #2 lists each register address and defines each of the states.

Register Address	Reference	Flag	Definition
400002	PLC flag	0	PLC busy
400002	PLC flag	1	PLC ready
400003	PC flag	0	PC busy
400003	PC flag	1	PC ready

Table 2. Control flag reference and definition chart.

After the spectrum has been collected, it is displayed. To calculate the area under a given peak, *Spectrometer.vi* sends the limits of integration (which are stored in a file) to *OMNIC*. *OMNIC* calculates the area of the spectrum between the given limits and returns the value. Upon receiving all the results, *LabView* closes the DDE conversation with the IRS. Results are stored in the PLC registers and in an *EXCEL* spreadsheet.

Off-site monitoring of system is provided via Internet.

Operating Procedure

Twenty different locations in the hall are monitored continuously. If above-threshold levels of CH or CO are detected, the PLC sends a signal to the enunciator panels located in the counting house and in Hall B. The enunciator generates an audible alarm alerting personnel of a potentially dangerous situation.

Conclusion

The system as implemented is operating reliably.

Appendix A

Technical information on the PLC, IRS and the PC is provided below.

PLC

Manufacturer and Series: Modicon TSX Automation Series

Module Configuration:

PLC module configuration

140 CPS 114 10 115/230 VAC Power Supply	140 CPU 113 02 CPU module, 256k RAM	140 ACI 030 000 8 channel Analog Input Module	140 ACI 030 000 8 channel Analog Input Module	140 ACI 030 000 8 channel Analog Input Module	140 ACI 030 000 8 channel Analog Input Module	140 NOE 211 00 Ethernet TCP/IP Module	140 DRC 830 00 Relay (NO/NC) Output Module 8 contacts	140 NOM 211 00 MODBUS PLUS Module

IRS

Manufacturer and Model: Nicolet Fourier Infrared Protégé 460 Spectrometer

PC

Manufacturer and Model: Digital Venturis fx 5166

- 166MHz Pentium(r) processor
- 80MB RAM
- 1.51GB hard drive
- 512k cache
- Windows 95 version 4.00.950.B operating system
- Network name *IRSpect* and IP 129.57.160.35

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