

SCADA (Supervisory Control & Data Acquisition) system at Mahanagar Gas Limited (MGL)

Sanket Kshirsagar*

Manager (O&M)

MAHANAGAR GAS LIMITED

Navi Mumbai, Maharashtra – 400709

Email – skshirsagar@mahanagargas.com

ABSTRACT

Mahanagar Gas Limited (MGL) is one of India's leading natural gas distribution companies. Established on 8th May, 1995, MGL is a joint venture between GAIL (India) Ltd and British Gas Asia Pacific Holdings Pte Ltd. MGL has to its credit the distinction of pioneering the natural gas distribution network in Mumbai and its neighboring areas. MGL today is an ISO 9001:2008, ISO-14001:2004 and OHSAS 18001: 2007 certified organization.

Presently, MGL has already connected approx. 0.82 million households and over 2600 small commercial and 55 industrial establishments. MGL also supplies CNG to more than 0.42 million vehicles which include above 0.19 million rickshaws and over 0.05 million taxis & above 0.18 million cars in Mumbai, Thane, Mira-Bhayander, Navi Mumbai and beyond. Besides, about 3400 BEST/TMT/MSRTC/NMMT buses and above 5000 LCVs/Tempos/Trucks/Private buses are running on CNG supplied through its wide distribution network of above 400 kms of steel and over 4000 kms of MDPE pipeline system and over 180 CNG filling stations having more than 1000 dispensing points.

Safe and uninterrupted supply of gas to the customers is the priority of the company. To ensure safety, MGL has put in place robust systems and processes which match with the best in the world. MGL has adopted a Health, Safety, Security & Environment (HSS&E) Management system which provides a framework for continual improvement in its performance.

Besides, MGL has implemented **SCADA (Supervisory Control & Data Acquisition) system** for real time monitoring, controlling and data acquisition of Gas Terminals, CNG Stations and Steel Valves.

KEY WORDS

SCADA Architecture, Communication Network, SMCC, MCC, Cathodic Protection CP system

1.0 INTRODUCTION

SCADA is an acronym for Supervisory Control and Data Acquisition. SCADA systems are used to monitor and control a plant or equipment in industries such as telecommunications, water and waste control, energy, oil and gas refining and transportation. These systems encompass the transfer of data between a SCADA central host computer and a number of Remote Terminal Units (RTUs) and/or Programmable Logic Controllers (PLCs), and the central host and the operator terminals.

A SCADA system gathers information (such as where a leak on a pipeline has occurred), transfers the information back to a central site, then alerts the home station that a leak has occurred, carrying out necessary analysis and control, such as determining if the leak is critical, and displaying the information in a logical and organized fashion. These systems can be relatively simple, such as one that monitors environmental conditions of a small office building, or very complex, such as a system that monitors all the activity in a nuclear power plant or the activity of a municipal water system. Traditionally, SCADA systems have made use of the Public

Switched Network (PSN) for monitoring purposes.

Today many systems are monitored using the infrastructure of the corporate Local Area Network (LAN)/Wide Area Network (WAN). Wireless technologies are now being widely deployed for purposes of monitoring.

The **SCADA (Supervisory Control & Data Acquisition) system** has been installed and commissioned in Mahanagar Gas Ltd (MGL) for the safe and efficient operation of the City Gas Distribution (CGD) network and pipeline facilities geographically spread around the city of Mumbai and its suburbs, Navi Mumbai, Taloja and Ambernath.

SCADA Master Control Center (MCC) had been set up in MGL CGS Mahape terminal, Navi Mumbai which is manned round the clock by SCADA operation engineers. The SCADA system operations at MCC are based on a 24 hour per day, 365 day per year schedule.

The SCADA system at MCC provides cohesive monitoring and control of the network and pipeline facilities such as City Gate

“MGL SCADA system communicates on Modbus TCP-IP protocol”

2.0 SCADA ARCHITECTURE

MGL has adopted Third Generation “Networked” Architecture type with “Replication & Redundancy” topology. In which there are two identical set of SCADA system located at two different places (especially in different seismic zones). One is termed as Master Control Center (MCC) and another Sub Master Control Center (SMCC).

Station (CGS), Sectionalizing Steel Valve Station (SV) and CNG compressor Stations.

The **SUB-Master Control Center (SMCC)** had been constructed in MGL CGS Wadala terminal, Mumbai for monitoring and control of the remote Stations such as CGS, SV, and CNG Stations in-case of any emergency at MCC in Mahape, Navi Mumbai. However, it is intension that control shall normally be from the MCC.

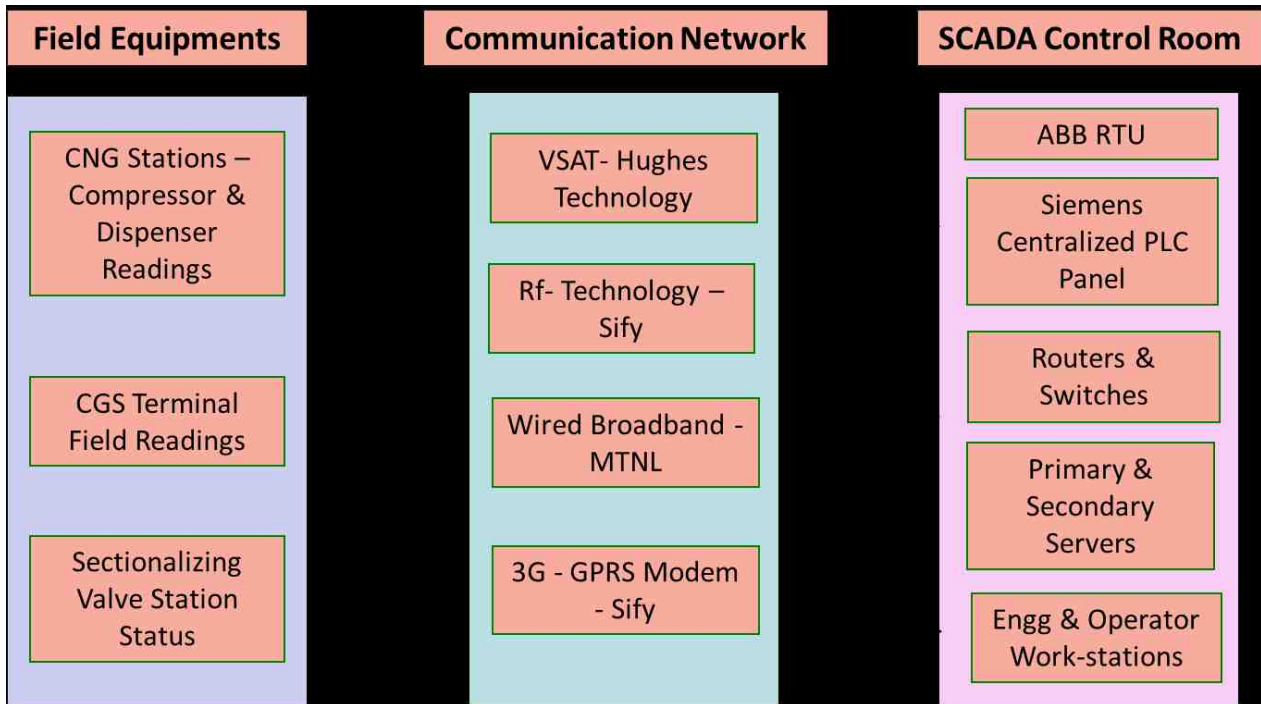


Figure (A): MGL SCADA schematic

MGL SCADA ARCHITECTURE

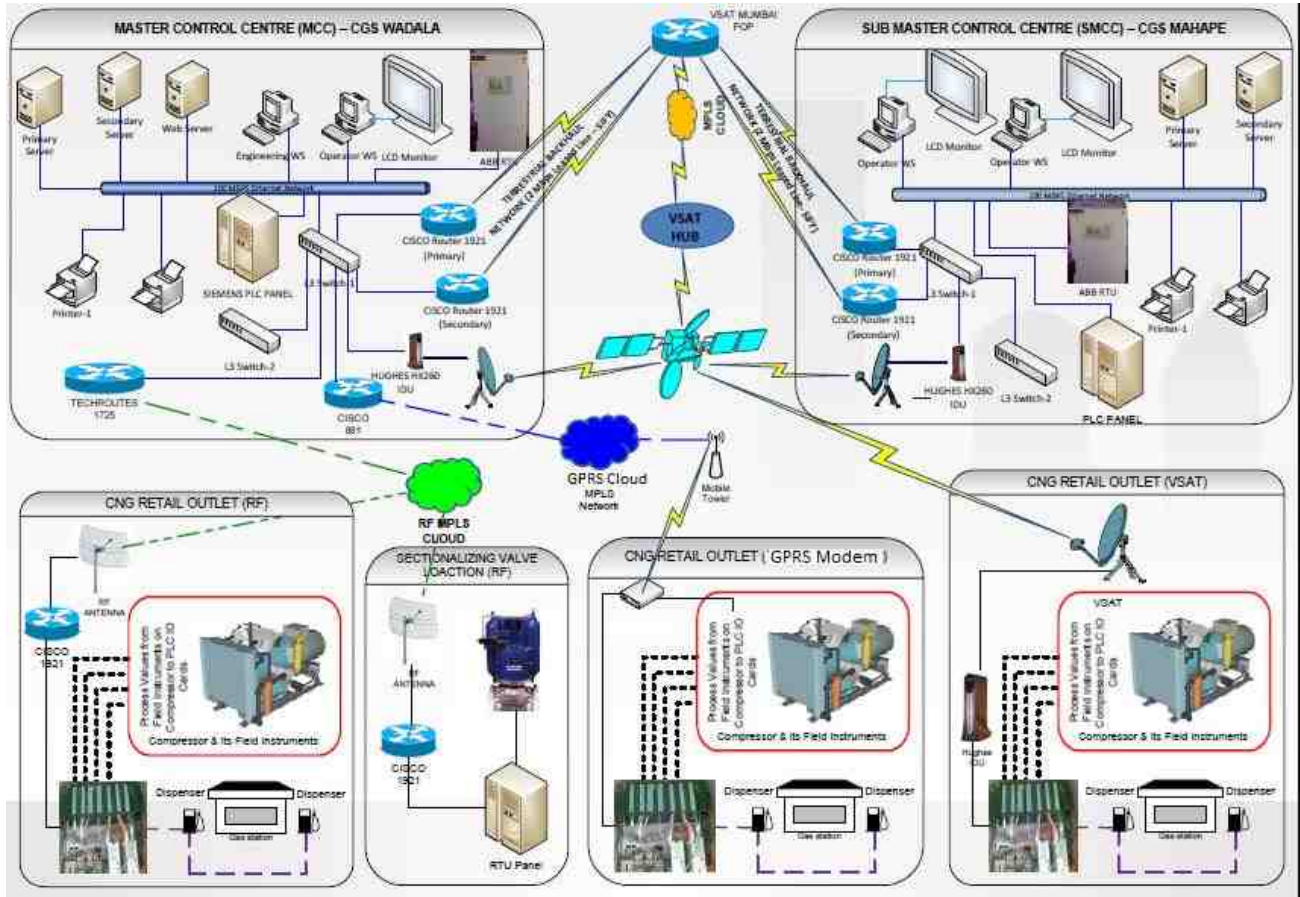


Figure (B): MGL SCADA Architecture schematic

The above picture gives the Bird-eye view of MGL SCADA systems and its integration with various MGL assets such as CNG Stations, Gas terminals & Sectionalizing Steel valve Stations via various mode of communication channels such as VSAT, Rf and GPRS. Now, we will elaborate further the each section of MGL SCADA System

2.1 SCADA CENTRALIZED CONTROL CENTER:

MGL SCADA Centralized Control Room is designed and build-up on Redundant Replication Model. Accordingly, Master Control room & Sub- Master Control room are constructed at different locations with similar architecture.

1. Master Control Center (MCC)

Master Control Center is located at CGS Mahape Terminal, Navi Mumbai and consists of the following

i. SCADA Servers:

A SCADA server consists of Primary and Secondary server which work on

iii. Centralized PLC Panel:

Active/ Stand-by Model. SCADA server is of Windows Server 2008 R2 loaded with SCADA software ABB SCADA Vantage version 5.3.1.

ii. Remote Terminal Unit:

Remote Terminal Unit (RTU) is supplied by M/s ABB. The all four Gas Terminals Measuring Instruments are integrated with SCADA system through RTU. The RTU process the following Measuring Instruments data and sends to server.

- Flow Computer (Make: Daniel Flowboss S600) and Make: RMG ERZ 2000) of USM.
- Odourant System Unit (Make: YZ system, Model NJEX 7300G).
- Gas Chromatograph (Make: Daniel Analyzer 500).

The centralized PLC Panel is supplied by M/s Siemens and is used exclusively to integrate the local Siemens make PLC with SCADA system. S7-400 PLC with redundancy has been used has centralized PLC to process the local Siemens make PLC (mostly S7 200 PLC) data and convert it into the Modbus data and send it to the SCADA server and vice versa.

Note: Other makes PLC such as Schneider M340 & TSX 1200 and GE Fanuc 90-30 series directly communicate with SCADA server on Modbus TCP/IP protocol.

iv. Routers & Switches:

Every network provider such as Hughes- VSAT, Sify- Rf& GPRS and MTNL- Wire broad band provides individual Routers (mostly CISCO make) and all this routers are connected to SCADA server through L3 Switch.

L3 Switch basically acts has a backbone which interconnects all devices such as ABB RTU, Centralized

PLC, Routers, Printers, Engineering & Operator Workstation etc in Master Control Room with SCADA Primary & Secondary server.

v. Engineering Work Station (EWS) & Operator Work Station (OWS):

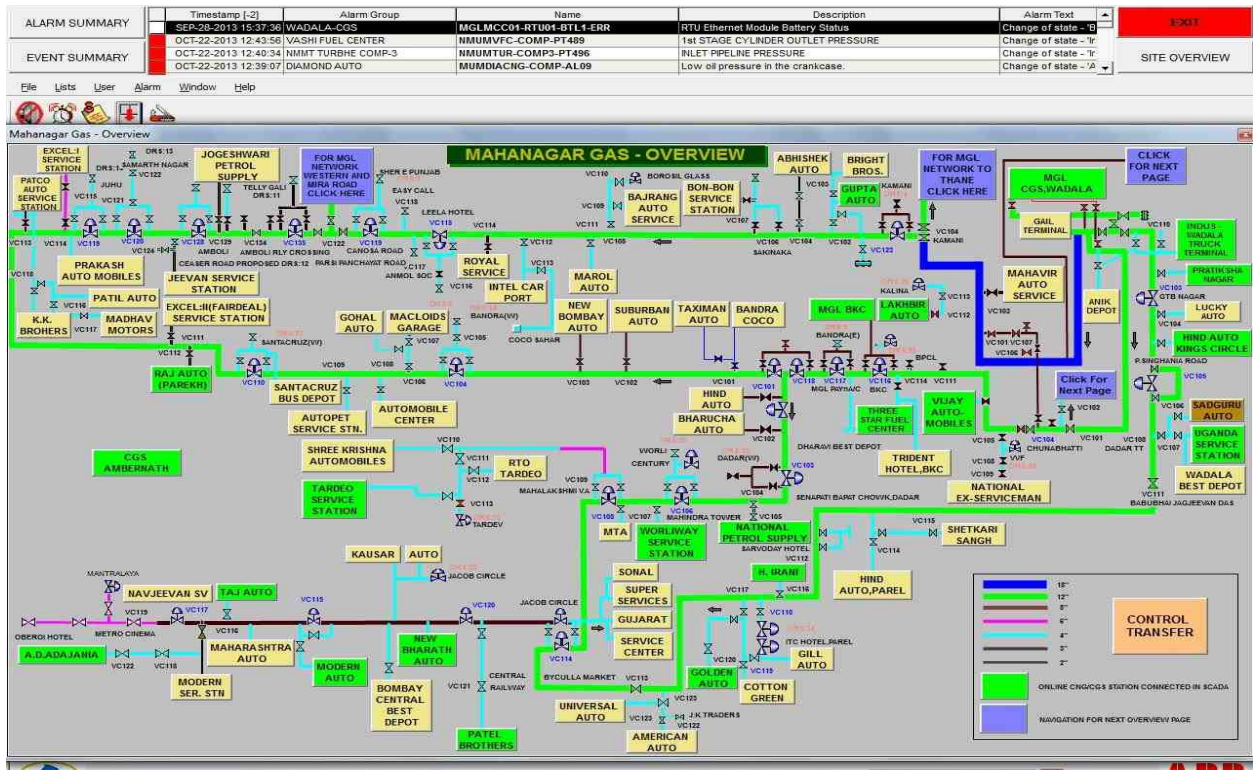
The Engineering Work Station (EWS) is high speed computer which is used to develop and create the SCADA Graphical User Interface (GUI). MGL SCADA GUI is basically developed on Visual Basic Platform. EWS is also used to do programming in ABB RTU. SCADA GUI Modification or Alteration rights are restricted to EWS.

Whereas Operator Work Station (OWS) can only display or read the GUI developed by EWS. Limited/ No modification or Alteration in SCADA GUI can be done from OWS

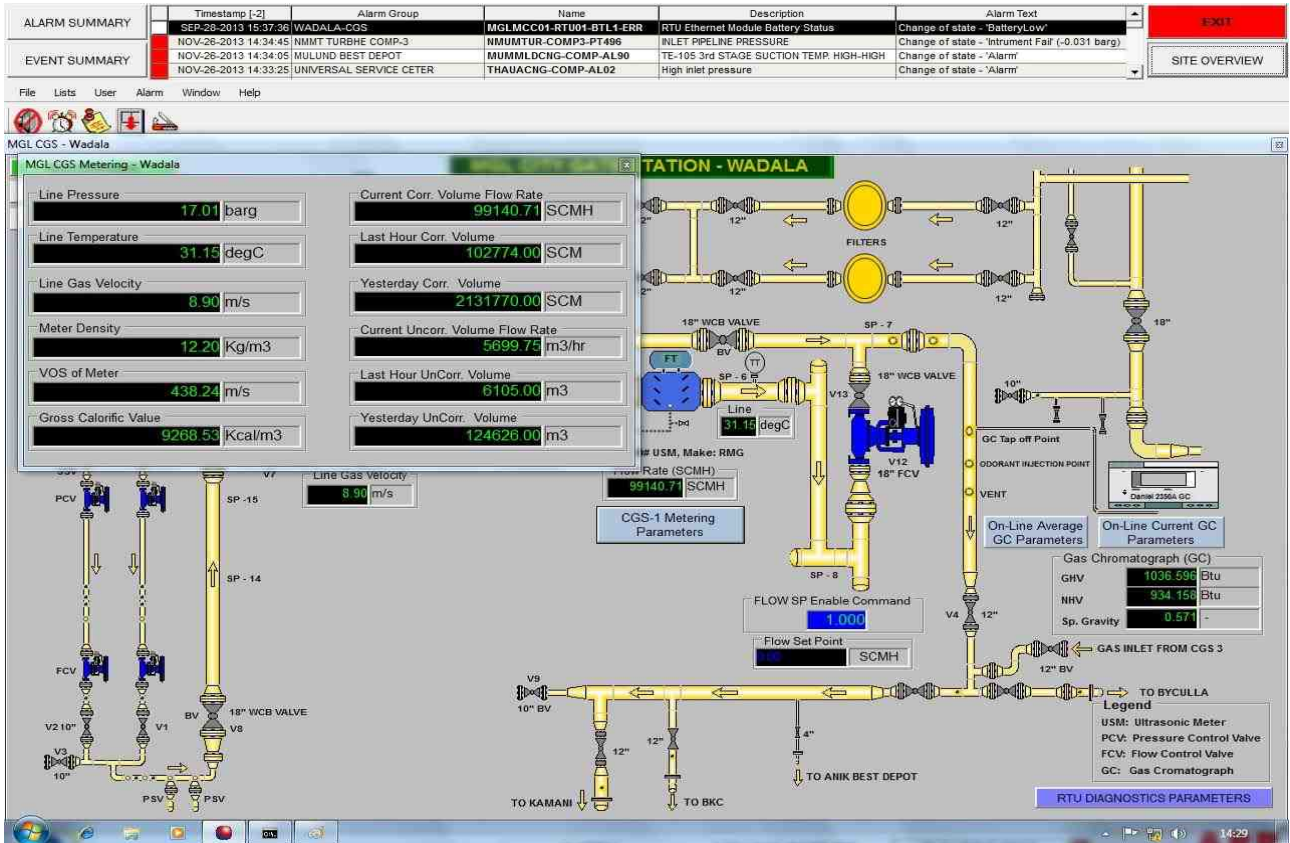
2. Sub- Master Control Center (SMCC)

Sub- Master Control Center is located at CGS Wadala Terminal, Mumbai and has same architecture that of Master Control Center except Centralized Siemens PLC Panel.

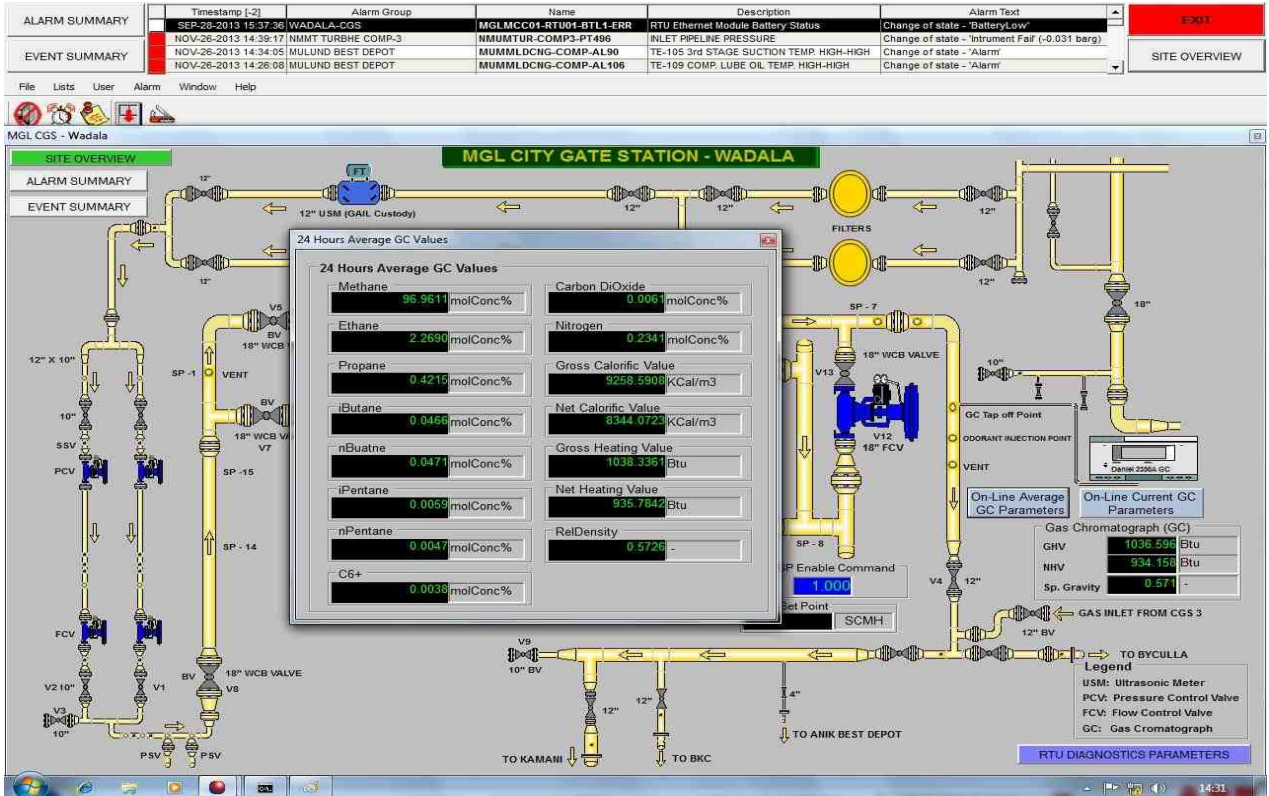
2.3 MGL NETWORK OVERVIEW GUI ON SCADA SYSTEM



2.4 CGS METERING SKID ON SCADA – GAS CHROMATOGRAPH OVERVIEW GUI



2.5 CGS METERING SKID ON SCADA – USM & FLOW COMPUTER OVERVIEW GUI



2.6 SCADA SYSTEM AT CNG STATION: -

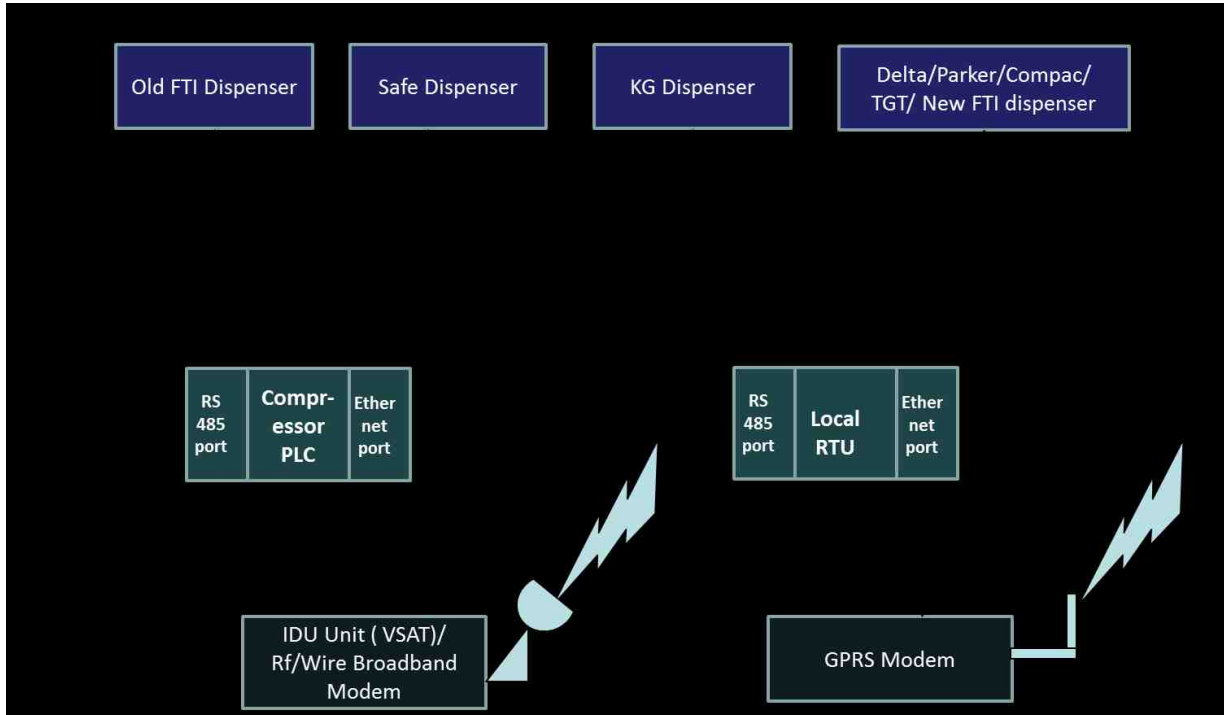
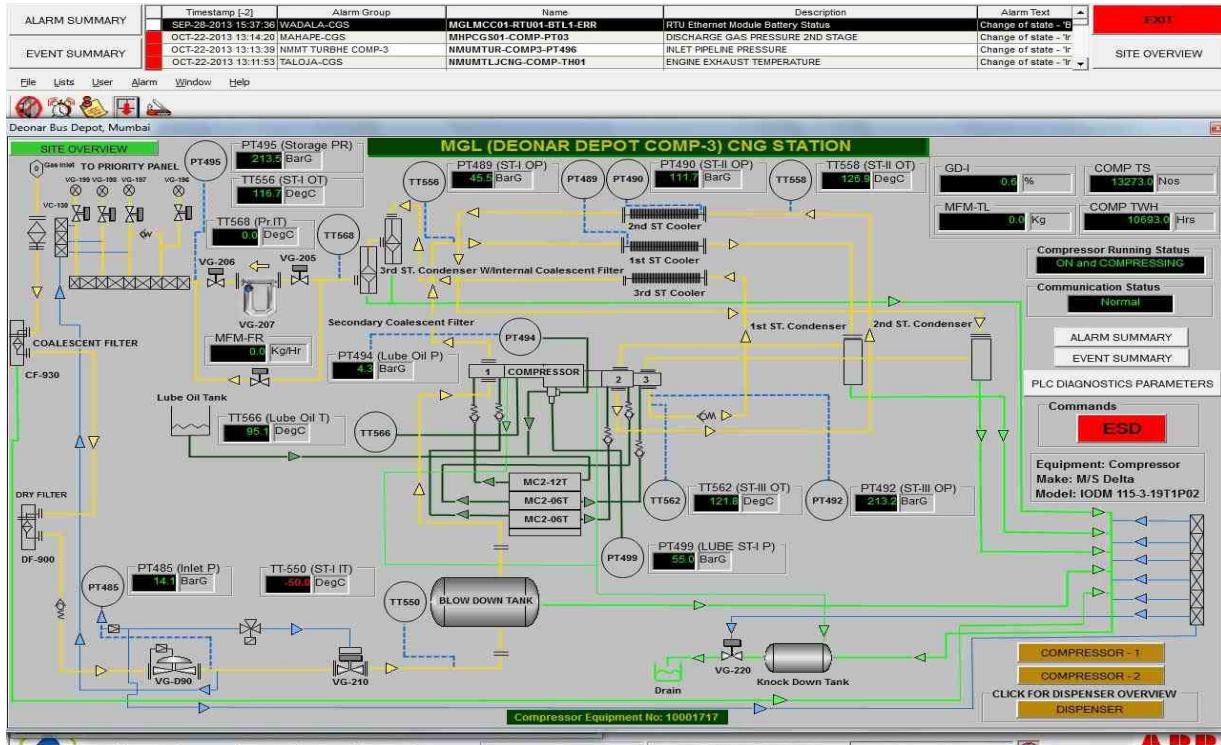


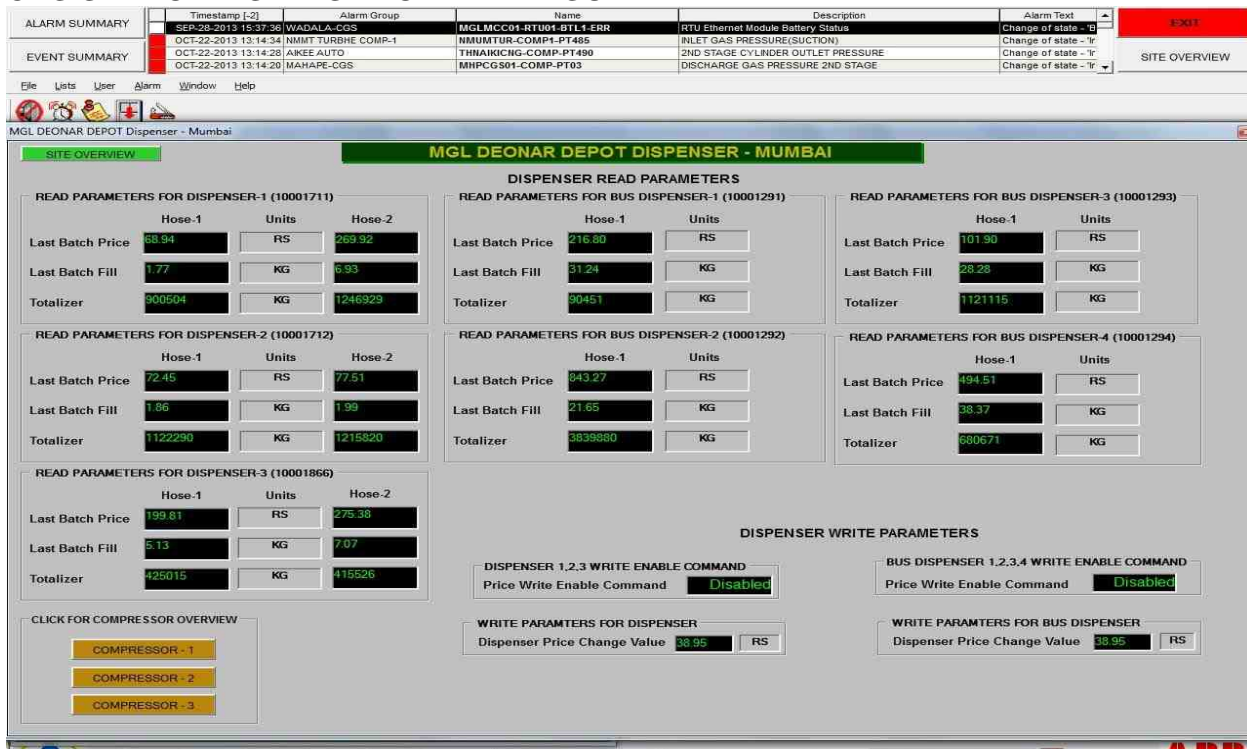
Figure (C): CNG Station SCADA system schematic

- i. CNG Station comprises of Compressor and Dispensers which communicate on Modbus RTU protocol and interconnected with RS-485 Profibus 2-wire cable.
- ii. Generally, dispensers communicate with their proprietary protocol and needs to be converted to Modbus RTU protocol by installing Protocol Converters in each dispenser.
- iii. The dispenser data is processed at compressor PLC and send to the modem along with compressor data on Modbus RTU encapsulated in Ethernet protocol. The compressor PLC and Modem is interconnected with CAT 6 cable.
- iv. The total compressor and dispenser real time data is then send to centralized Master Control Room server through Modem via VSAT/ Radio Frequency/ GPRS/ Wired Broadband communication network.
- v. MGL is also opting for SCADA system redundancy at CNG Station by installing additional Local RTU with GPRS Modem, so even if compressor PLC or Primary Modem fails the local RTU or GPRS Modem will take over accordingly.

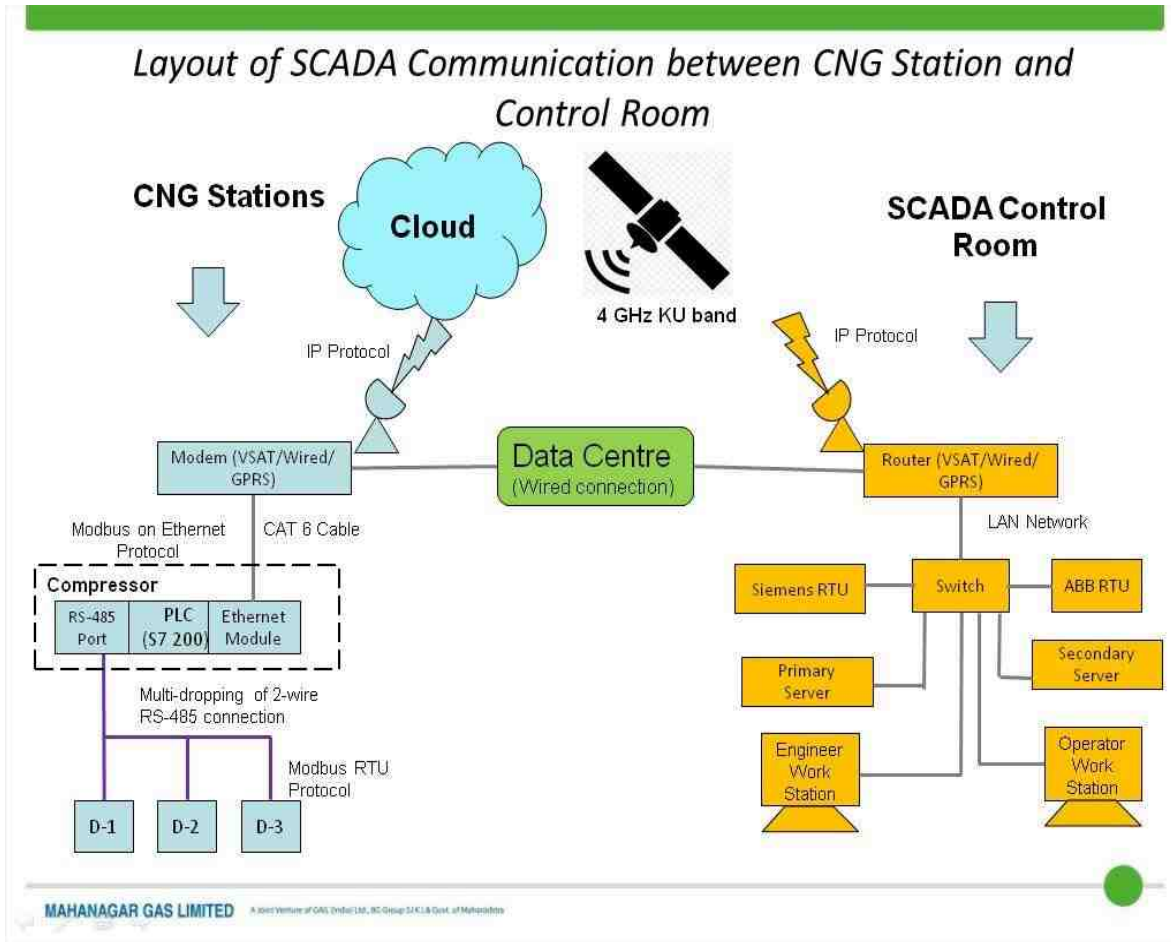
CNG STATION COMPRESSOR OVERVIEW GUI



CNG STATION DISPENSER OVERVIEW GUI



3. COMMUNICATION NETWORKS



MGL is using briefly 3 types of communication networks for its SCADA system

- 1. VSAT (Very Small Aperture Terminal)**
- 2. Wired (Leased / Broadband) connection**
- 3. GPRS technology (4G/ 3G)**

4.0 SECTIONALISING STEEL VALVE STATION (SV)

The Sectionalising steel valves station (SV) is installed to regulate the gas flow from main trunk gas pipeline of 12" size. These SV stations operate on Gas Over Oil Actuator (GOOA) – Emerson Shafer make, wherein the hydraulic (Oil) power is used to operate the main steel valve. The System provides Upstream & Downstream gas pressure of SV, Open/Close

Status of SV. The Valves can be operated in Local, Remote & Manual mode. The data from the SV is collected by Remote Terminal Units (RTU) installed at SV Location and send to SCADA server via RF Link. The entire SV Setup is powered using Solar Panels.

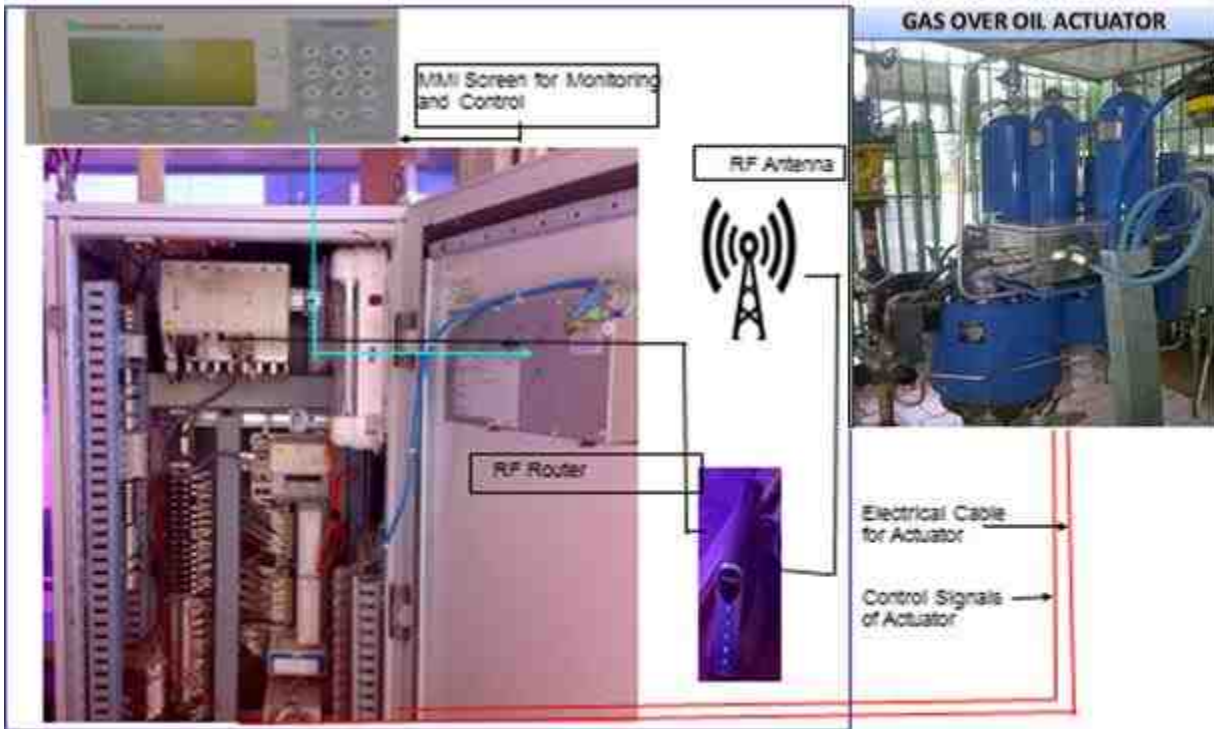


Figure (D) : SV- GOOA Communication Layout

SECTIONALISING STEEL VALVE STATION (SV) GUI



5.0 CASE STUDY: Cathodic Protection (CP) on SCADA SYSTEM

MGL steel pipelines are being protected by Impressed Current CP system. Considering the length and spread of the network, physical monitoring of the CP installations becomes a time consuming task. Also physical monitoring increases the response time of MGL engineers to breakdowns of CP system. In view of this MGL has adopted following real time corrosion monitoring and control practices.

- For External Corrosion – Remote Monitoring GSM Systems installed in Transformer Rectifier Units
- For Internal Corrosion – Internal Electrical resistance (ER) Probes

CATHODIC PROTECTION (CP) GUI
 CP system is integrated in SCADA system through “Data Mapping” type from its proprietary CP system server. Data Mapping type of integration is an indirect method of integration which is not directly on Modbus TCP/IP protocol or OPC protocol. Here, the data is extracted from SQL database of CP system server through pre-defined time intervals. The advantage of this system is that the data gets updated simultaneously in CP server and SCADA server.

TR No.	TR UNIT NAME	TR VOLTAGE (Volts)	TR CURRENT (Amps)	PSP (Volt)	AC VOLTAGE (Volts)	TR RUN HRS (Hours)	OVER PROTECTION	UNDER PROTECTION	REF. FAIL	DOOR ALARM
35	GODFREY PHILLIPS	4	0.47	-1.4600	245.70	7228.30	Normal	Normal	Normal	Close
36	CGS MAHAPE	3	2.55	-1.1938	230.10	163.20	Normal	Normal	Normal	Close
37	STATION 37						UNDEFINED	UNDEFINED	UNDEFINED	UNDEFINED
38	NMMT DEPOT TURBHE	1	0.05	-1.8968	247.40	11537.60	Normal	Normal	Normal	Close
39	RAJ ALITO SANPADA	2	0.10	-1.5348	267.60	16199.00	Normal	Normal	Normal	Close
40	GAURAV GAS NERUL	1	10.35	-1.5428	248.40	402.72	Normal	Normal	Normal	Close
41	BP BELAPUR	0	0.00	-1.2170	252.26	75.00	Normal	Normal	Normal	Close
42	BP KHARGHAR	1	0.47	-1.4978	238.33	121.00	Normal	Normal	Normal	Close
43	PANVEL FASTNER	4	1.67	-1.7600	1441.00	417.04	Normal	Normal	Normal	Close
44	CGS TALOJA	5	0.26	-1.2980	290.07	4512.61	Normal	Normal	Normal	Close
45	GTD NAGAR DS						UNDEFINED	UNDEFINED	UNDEFINED	UNDEFINED
46	JAI SHREE RAM	1	0.08	-1.7500	223.20	5869.90	Normal	Normal	Normal	Close
47	MAYA TRADERS	0	0.00	-1.2370	221.71	5429.13	Normal	Normal	Normal	Close
48	CGS AMBERNATH	21	4.16	0.0000	0.10	16189.90	Normal	Normal	Alarm	Close

ANNEXURE – I

OPERATIONAL PARAMETERS FOR MONITORING & CONTROL THROUGH MGLSCADASYSTEM

A) CNG stations

Compressor Monitoring Parameters

- 1) Crank system lube oil pressure
- 2) 1st Cylinder lube oil pressure
- 3) Inlet gas pressure
- 4) 1st Stage cylinder outlet pressure
- 5) 2nd Stage cylinder outlet pressure
- 6) 3rd Stage cylinder outlet pressure
- 7) Priority panel inlet pressure (storage)
- 8) Crank system lube oil temperature
- 9) 1st St. Cylinder gas outlet temperature
- 10) Compressor running status
- 11) 2nd St. Cylinder gas outlet temperature
- 12) 3rd St. Cylinder gas outlet temperature
- 13) Priority panel inlet temperature
- 14) 1st St. Cylinder gas inlet temperature
- 15) Gas detector
- 16) Discharge mass flow rate
- 17) Discharge mass flow rate totalizer
- 18) Total working hours
- 19) Total starts
- 20) All alarm conditions

Controlling Parameters

- 1) Emergency shutdown command

Dispensers Monitoring Parameters

- 1) Dispenser last batch fill Kg
- 2) Dispenser last batch fill Rs
- 3) Dispenser totalizer

Controlling Parameters

- 1) Unit price change enable command
- 2) Unit price value change command

B) Sectionalizing valve stations (SV) **Monitoring & control parameters**

- 1) Valve open/close status
- 2) Local/remote operation mode
- 3) Upstream pressure before SV
- 4) Downstream pressure after SV
- 5) Valve open/close command

C) City Gate Stations / Gas Terminals **Monitoring USM & Flow Computer parameters**

- 1) Line pressure
- 2) Line temperature
- 3) Flow rate
- 4) Meter density
- 5) Current uncorrected volume flow rate
- 6) Last hour uncorrected volume
- 7) Yesterday uncorrected volume
- 8) Current corrected volume flow rate
- 9) Last hour corrected volume
- 10) Yesterday corrected volume

Monitoring Online GC parameters

- 1) Methane
- 2) Ethane
- 3) Propane
- 4) nButane
- 5) iButane
- 6) nPentane
- 7) iPentane
- 8) Gas density
- 9) C6+
- 10) Carbon dioxide
- 11) Nitrogen
- 12) GHV
- 13) NHV
- 14) Real density
- 15) Compressibility factor
- 16) Total uncorrected concentration

REFERENCES

- [1] Bela G. Liptak, Networks in Process Automation, Hardware Structures and Integration of Process Variables into Networks.
- [2] National Institute of Standard and Technology, Guide to Supervisory Control and Data Acquisition (SCADA) and Industrial Control Systems Security 2006.

- [3] NATIONAL COMMUNICATIONS SYSTEM TECHNICAL INFORMATION BULLETIN 04-1 Supervisory Control and Data Acquisition (SCADA) Systems, 2004
- [4] IS 15654 - Indian Standard SUPERVISORY CONTROL AND DATA ACQUISITION (SCADA) SYSTEM FOR OIL AND GAS PIPELINE

Presenting author Biodata

Name : Mr. Sanket Kshirsagar

Designation : Manager – O&M

Company : Mahanagar Gas Ltd.

Qualification : M.B.A, B.E (Instrumentation)

Area of Expertise : PLC Programming, SCADA Automation, CNG
Compressors and Dispensers operations



Significant Achievements: Implementation of SCADA system at MGL

Number of Papers Published in Journals: 0

Number of Papers Published in Conferences: 01