A

Project Report on

Automatic Meter Reading for City Gas Distribution

By

Pankaj R. Raut

(M.Tech Gas Engineering)

(Roll No. R030204014)

Under the Guidance of

Mr.Kamal Bansal

(Associate Professor, COE, UPES)

A project report submitted in partial fulfillment of the requirements for MASTER OF TECHNOLOGY IN GAS ENGINEERING of University of Petroleum & Energy Studies

Harnessing Energy through Knowledge

University of Petroleum & Energy Studies

College of Engineering

Dehradun, INDIA

May 2006

Acknowledgement

This is to acknowledge with thanks, the help, guidance and support that I have received from **Mr.Kamal Bansal(Associate Professor,COE,UPES)** which has been of inestimable value in my pursuit of completion of this dissertation work.

Also I am grateful to **Dr. B.P Pandey (Dean,COE, UPES)** for all the encouragement to pursue my Dissertation work.

Also I am thankful to **Mr.R.P.Badoni (Programme coordinator,COE,UPES)** and **Dr.D.N.Saraf (Distinguished Professor, COE, UPES)**,for their valuable support.

I am thankful to **Mr. Suvendu Mohapatra(Assistant Manager),Adani Energy(Gujarat) Limited** for all his assistance, support and suggestion for the thesis work.

I am very much obliged in showing my gratitude to the management of **Actaris Metering Systems, New Delhi** for giving me initial support, in particularly **Mr.Pravin Aswani (Regional Manager-West),Actaris Industries Pvt. Ltd.**

Pankaj R. Raut
M.Tech (Gas Engineering)
University of Petroleum & Energy Studies (UPES)
Dehradun.

Certificate

This is to certify that the project report on **"Automatic Meter Reading for City Gas Distribution"** submitted to University of Petroleum & Energy Studies, Dehradun, by **Mr. Pankaj Raut**, in partial fulfillment of the requirement for the "M.Tech in Gas Engineering", is a bonafide work carried out by him under my supervision and guidance. This work has not been submitted anywhere else for any other degree or diploma.

Dr. B.P.Pandey 16/05/06

Dean
College of Engineering
UPES, Dehradun

Certificate

This is to certify that the project report on "**Automatic Meter Reading for City Gas Distribution**" submitted to University of Petroleum & Energy Studies, Dehradun, by **Mr. Pankaj Raut**, in partial fulfillment of the requirement for the "M.Tech in Gas Engineering", is a bonafide work carried out by him under my supervision and guidance. This work has not been submitted anywhere else for any other degree or diploma.

11th May 2006

Mr. Kamal Bansal
(Associate Professor, COE,UPES)

11th May 2006

CONTENTS

List of Figures

List of Tables

Executive Summary

Increasing costs for **petroleum products** and the **volatility of prices** have now lead many customers to look for more **sophisticated** ways to understand and control their demand in real time. With the cost for metering devices coming down coupled with federal mandates and state incentives for installing advanced metering systems, automating the meter reading process is finding new justification and traction.

Many states have already implemented AMR (Automated Meter Reading) systems. Many other facilities such as water, electricity has followed the suit. Interval meters combined with software that analyzes usage patterns and trends are now providing customers with the ability to more precisely understand and control demand than ever before.

Scope of the Project: -

With rising energy costs there is an increased need to identify utility usage and waste. In order to operate a system in a more **efficient** and **economical** way steps should be taken in order to reduce consumption through a remote monitoring telemetry solution for gas metering.

Reliable, efficient and effective connections are key to success in the utility industry.

Today's market demands ever-stronger connections with customers, regulators, business partners and stakeholders—and the technologies that make it all happen.

Importance of the project: -

Business challenge - Meter Reading – Accurate and Timely Reading

With rising energy costs and environmental pressures through the climate change Levy, there is a growing need to reduce energy consumption. Reducing losses and waste, and adopting energy efficient products and technology can achieve this. Predicting energy usage remains a key issue in an industry where downtime is unacceptable.

However, since energy losses are not easy to identify, it is difficult to determine the key culprits whether they are human users or Energy -hungry equipment. In many cases it is difficult to store energy, which must be generated to fulfill immediate demand. **Predicting energy usage** remains a key issue in an industry where **downtime is unacceptable**, which is difficult by slow access to the remote meter readings.

This Project report gives the **insight** of technical aspects of Automatic Meter Reading and its **viability** with respect to conventional metering system.

Chapter 1

Conventional Metering

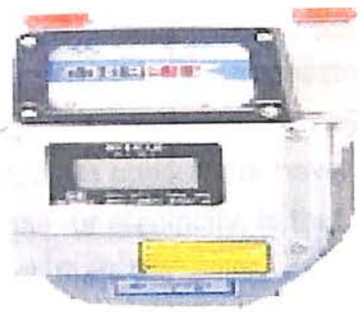


Fig.1 Conventional Meter with readout system

The traditional utility meter displays energy usage as an accumulation of counts presented to a display, which is used to calculate the monthly energy bill. Meters have applications within the electricity, gas and water utility industries for domestic, commercial and industrial applications.

Currently the utility provider does meter reading by conventional method. Personnel of the utility provider visits the site where there meters are installed by taking the final/current reading and comparing that reading with the initial reading the number of units consumed were calculated. These units were then multiplied by corresponding rate for per unit consumption and accordingly billing was done.

There were many lacunae's in the above metering as the calculation was done on the **estimated** basis. Again there were **errors** on the part of reader who is collecting the readings of different meter on monthly basis.

Sometimes it may happen that meters are located at some **inaccessible area** which may lead to the accident of the personnel.

In order to collect data from site where particular meters were located utility provider has to hire personnel on monthly basis, which **costs to utility**.

Also this type of conventional metering was not giving the **exact energy** consumption where prices are changing from time to time.

Detection of thefts and tampering at the customer end was not easily recognized by utility.

Utility providers were looking out for certain automated system, which could enhance the productivity of their service to customer and enhance profits.

1.1 Emergence of AMR: -

As energy and utility service prices rise, increasing numbers of consumers are looking for ways to manage the amount of money spent on electricity, gas and water. The fundamental problem consumers have in managing their use of utility commodities, be it water, gas, or electricity, is that there is no practical way to tell how much of each product they are using and therefore how much they are spending at any point in time. Further, they do not know how much it costs to use a given appliance, maintain a certain household temperature, or water the lawn.

Utility companies have no way to know how much electricity, gas or water customer's use in real time. They cannot tell what the maximum peak amount of electricity, gas or water was used nor can they develop a correlate between time of service use and amount. The overwhelming majority of residential utility accounts are billed by taking an accumulation of services used over a thirty-day period of time. As a result of these metering limitations, consumers don't receive the benefit of flexible pricing options that more closely match their individual usage profiles.

Further, a utility typically obtains these accumulated monthly readings by sending a human meter reader to each and every account to visually inspect a local utility meter and manually record the readings in some type of hand held data terminal. Many residences have metered electric, gas and water services with local meters read once a month by different meter readers representing each utility service. This represents a significant cost to the utilities and their customers. There are also liability issues in these security conscious times.

Recent advances in microelectronics and communications technology have vastly outpaced the traditional installed means of metering, meter reading and billing. Today's technology can provide the consumer up to the second real time and accumulated energy usage and pricing information, provide the means to manage and control such usage, and automatically transport this information to multiple utilities such as electric, gas and water. The same technology provides the utilities significant positive economic advantages based on new control ability, reduction of operating expenses and new revenue streams resulting from new value added products and services. Further, new financing alternatives are created which eliminates the necessity of the utility having to pay for the acquisition costs associated with the new metering equipment. Cash strapped utilities can use these advantages to help return to profitability.

1.2 Background of AMR systems: -

In the mid to late 1990s it was generally accepted that deregulation was going to change the structure of energy utility services in many if not most states by giving the consumer the power to choose their energy supplier. Customer choice and competition would stimulate suppliers to provide low-cost Energy and to introduce a variety of advanced and diverse services. Experiments with deregulation have not yet been fine-tuned to produce the anticipated results and more time is needed to study the viability and best methods of deregulation. One key advanced technology promoted through the initial steps of deregulation has proven itself. Utility companies nationwide have embraced Automated Meter Reading and even Real Time Metering and placed it on the top of their list of ways to reduce operating costs and improve the level of Customer Service.

The term Automatic Meter Reading or AMR has, unfortunately, been misused. Literally, the term implies reading an entire population of utility meters without human intervention and processing the resultant data leading to the preparation of the customer's monthly bill. In the twenty- first century, however, AMR must be truly automatic, without human intervention. This requires the local capture of meter data at the service subscriber's meter and the remote telemetry of the data via some type of networked communications. And, given the current level of data acquisition, micro computing, and communications technology, AMR is naturally evolving into Real Time Metering or RTM.

In the early 1980s the trend began to replace card and pencil based manual reading systems with electronic hand held data terminal based systems. This was typically referred to as EMR or Electronic Meter Reading. This was the beginning of the gradual process towards meter reading automation. The use of a hand held data terminal by a human meter reader greatly increased accuracy, reduced re-reads and increased the number of meters read per route but still required routes to be walked by fleets of meter readers.

In 1992 the first field trials were held in Garland, Texas and Dallas which implemented radio transmitters placed inside standard electro-mechanical meters and which were "read" by hand held terminals containing receivers thus allowing a meter to be read remotely, but not automatically, from distances up to several hundred feet away. This was the **beginning of the current era of AMR**.

1.3 Classification of Areas for AMR Installation: -

For the cost-benefit analysis, the customers using the gas Meter's are separated into three types of AMR systems:

1. C&I AMR systems, which are focused on providing enhanced meter management services to the **larger C&I customers**. Here the importance of AMR lies in collection of timely revenue as this are the **bulk** consumers.
2. Metro Area AMR systems, which are designed for wide-scale implementation in densely, populated urban areas of smaller commercial and residential customers. Here the utility of AMR lies in managing **large number** of meter's, their readings, and collection of revenue within the stipulated period of time.
3. Rural Area AMR systems, which are designed for residential customers in thinly, populated rural areas. Here the feasibility of implementing AMR lies in how many meters are located and at what location ex hilltop, certain **inaccessible Area** etc.

Chapter 2

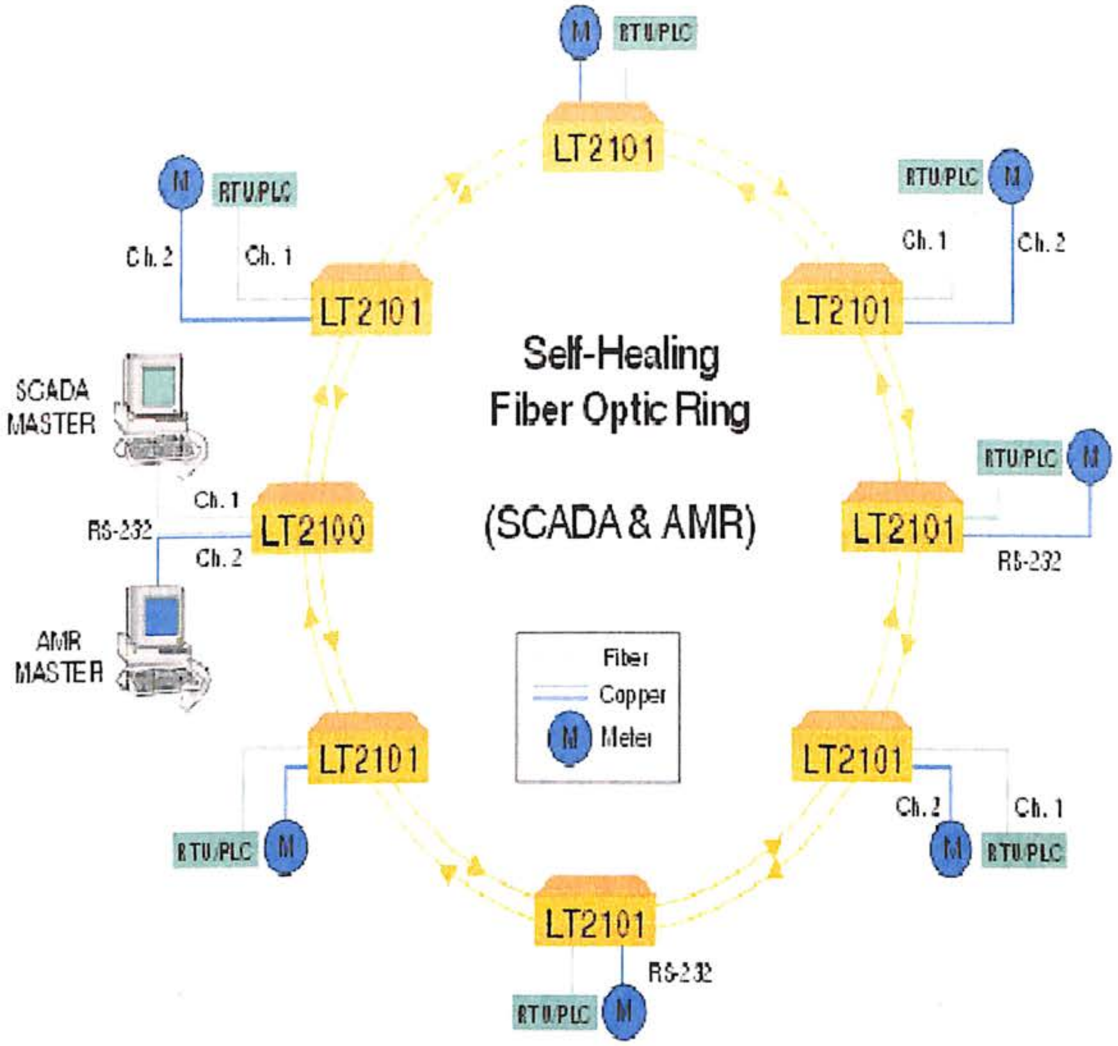
Introduction to Automatic Meter Reading

AMR systems gather metering data that documents the **purchase** and **sales** of natural gas. This metering data is crucial to the transmission or distribution company as it documents how much gas has passed through a point, a custody transfer point, on the pipeline and in doing so has changed ownership. The metering data is subsequently passed on to accounting departments for validation and billing purposes. AMR systems have architectures similar to SCADA with field devices that meter gas flow at distributed assets, host computers that collect the meter data, and telemetry systems that connect the field devices and host computer.

The automation systems that control and measure natural gas flow in transmission and distribution pipelines often involve two systems. The system that controls the gas flow in a pipeline is called a **SCADA** (Supervisory Control and Data Acquisition) system and an **AMR** (Automated Meter Reading) system measures the amount of gas flowing into, and out of, the pipeline.

These automation systems which can be completely separate or combined are widely distributed throughout the service area of a pipeline and must rely heavily on long-distance communication technologies to telemeter the data necessary to coordinate and monitor pipeline activities. This is the most challenging aspect of the automation problem as the communication system is the most exposed component to service interruptions and degradation.

SCADA and AMR systems are installed in the **redundant configuration**. Fig.2 displays the RTU's (Remote Terminal Units) which acts as the data-concentrators which collects data from all the meters which are located in its premises normally 50-100 meters by GSM Towers, Power line carriers.



Typical SCADA and Automatic Meter Reading (AMR) Application

Fig.2: SCADA and AMR

Automatic Meter Reading presents a simple solution where by a central application polls the remote utility meter using protocols such as **IEC 1107**. Pulse outputs from the meter can be monitored externally as part of wider equipment monitoring solution where reducing energy usage is key. A wider monitoring system determines usage over time, identifies peaks, compares sites and correlates use with offending equipment and people.

Chapter 3

Overview of AMR system

AMR stands for Automatic Meter Reading.

When automated equipment or an infrastructure is installed to read utility meters that does not require a meter reader to physically access the meters.

"The AMR system starts at the meter. Some means of translating readings from rotating meter dials, into digital form is necessary in order to send digital metering data from the customer site to a central point".

AMR uses radio frequency technology. Normally old meters have to be retrofitted with electronic transmitter device. The electronic transmitter device installed on the meter is programmed to automatically send the meter reading twice a day. The signal is sent to a data collector installed on a building or electric pole serving a particular area or a tower. Daily, the collector sends the meter readings to the host computer located at customer service headquarters.

Each meter and transmitter has a unique identification number that ensures that only the person who owns the meter should be bearing the bill, reading assigned to his account. The meter reading information is unloaded into the city's data system for customer questions and billing.

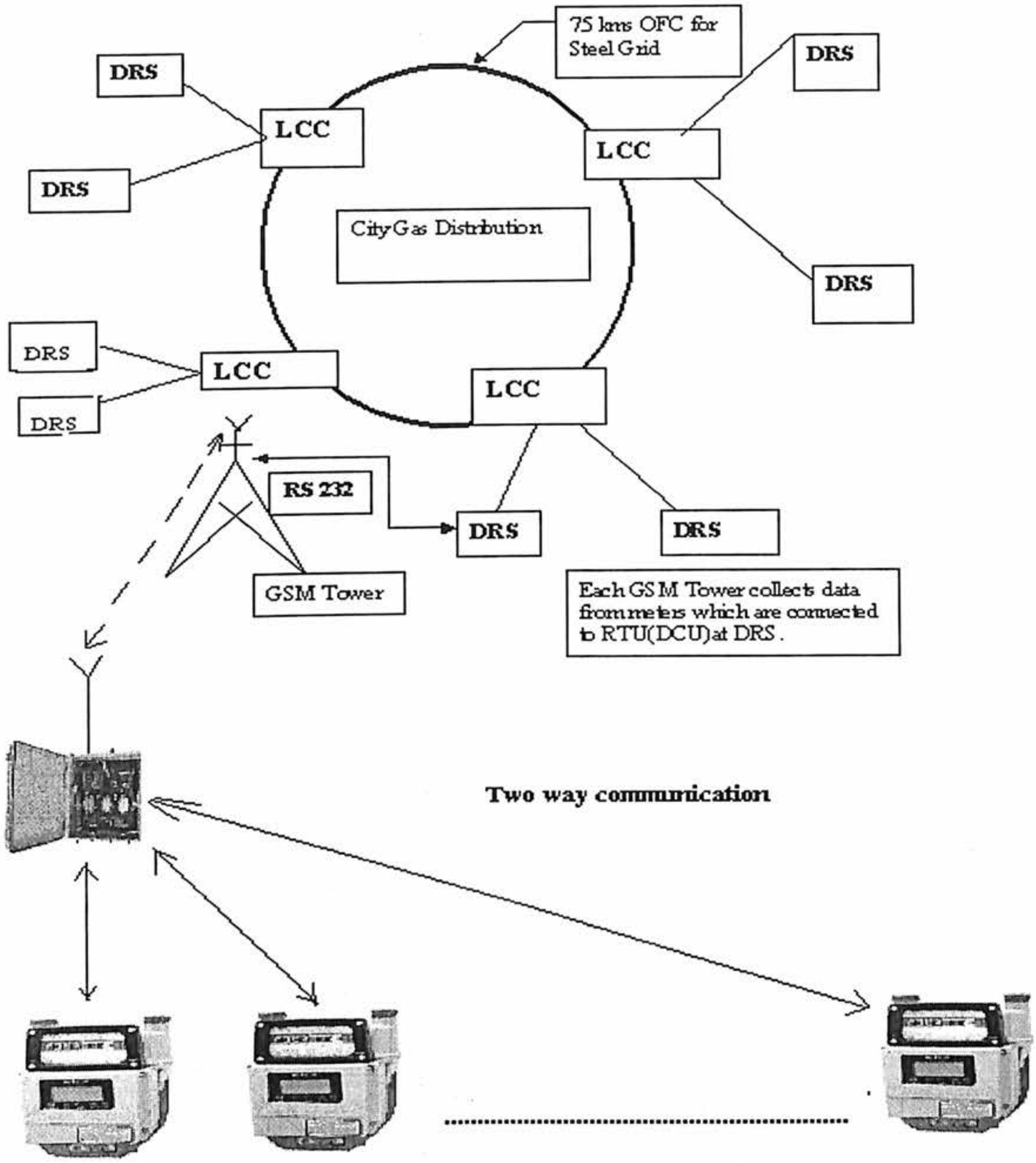


Fig.3 Overview of AMR system

Chapter 4

Meter Reading Techniques

AMR solution choices:

- Touch Read type systems.
- Handheld radio AMR.
- Mobile radio AMR.
- **Fixed network radio AMR.**
- Telephone AMR.
- Power line AMR.
- Hybrid system solutions.

4.1. Touch Read Type Systems:-

Operation:-

- Use of inductive coupling that is remote and connected to an electronic meter index/register.
- Reading device has matching coupling– Visual reader or handheld device.
- Automates meter reading data transfer.
- For inside and hard to read meter installations – Most popular at water utilities, but has been used by gas and electric utilities for hard to read meters.

System benefits:-

- Eliminates human error when used with handheld.
- Good for inside set meters.
- Most systems today compatible with popular handheld systems.
- Cost benefits when segmenting routes – i.e. hard to read locations, inside meters, safety areas.
- Meters ready for AMR.

4.2. Handheld Radio AMR Systems:-

Operation:-

- Meter reader uses a handheld device with an RF interface that reads meters on the meter route with a compatible radio AMR endpoint connected.
- Further automates meter reading process in that meter reader only needs to be "in range".
- Two system types
  - 2way – meter reader presses button on handheld that sends alert signal to meter end point which responds with meter reading data.
  - 1way– meter transmits meter reading data at some transmit interval, usually 4 - 6 seconds – meter reader needs to be "in range" with handheld device.

System Benefits:-

- Greatly improve meter reader efficiency on walking route.
- Selective installation in conjunction manual reading route – hard to read, safety areas.
- Most systems migrate to mobile drive by system.
- Some systems with combo-utility capability.

4.3. Mobile Radio AMR Systems: -

Operation:-

- Similar to handheld operation except meter reader drives a vehicle on the meter routes which has an RF interface that reads meters with a compatible radio AMR endpoint connected.
- Another level in the meter reading process in that meter reader only needs to be "in range" to read meters.

• Two system types

2 way – as meter reader drives the route the mobile reading equipment automatically sends alert signal to meter endpoint which responds with meter reading data.

– 1way – meter transmits meter reading data at some transmit interval, usually 4-6 seconds.
– mobile reading equipment needs to be "in range" to receive data.

System Benefits: -

• Read multiples more meters than walking systems –especially on dense meter routes.
• Accurate read no manual entry.
• Provides read once a month.
• Can do meter reading at off-peak times – Example – 11:00 pm to 7:00 am shift.
• Some systems migrate to fixed network AMR system.
• Some systems with combo-utility capability.

4.4. Telephone AMR Systems: -

Operation: -

• Meters linked to the telephone network via a meter interface unit or integrated communications board.
• Systems can be wired or wireless.
• Meter reading data goes through telephone network infrastructure to host computer with AMR software.
• Two types of telephone based systems

– Call inbound – meters programmed to "callin" to the system host computer at a determined time interval.
– Call outbound – meters can be called from the host computer requesting reading data or even provide a meter command.

System Benefits: -

- Meters read using established and reliable communications infrastructure.
- Daily or more frequent meter readings - Meter can be accessed at any time.
- Works with both outbound and inbound systems.
- Improves utility meter reading efficiencies

– Eliminates or minimizes final reads (move ins/outs).

– Utilize soft turnoffs – monitor usage at unoccupied site.

– Enhanced customer service – daily reading data.

- Eliminates or greatly minimizes reread verifications.
- Good for large data packets.

4.5. Fixed Network Radio AMR Systems:-

Operation:-

- Meters connected to wireless AMR device that links to an installed radio network Infrastructure.
- Meter reading data goes through network infrastructure to host computer with AMR Software.
- Two types of systems

– 1way – meters programmed to transmit at a determined time – common 24 times per day.

– 2way – meters can be addressed requesting a read from a host computer located at the utility office.

- (one way more common in gas market due to battery life)

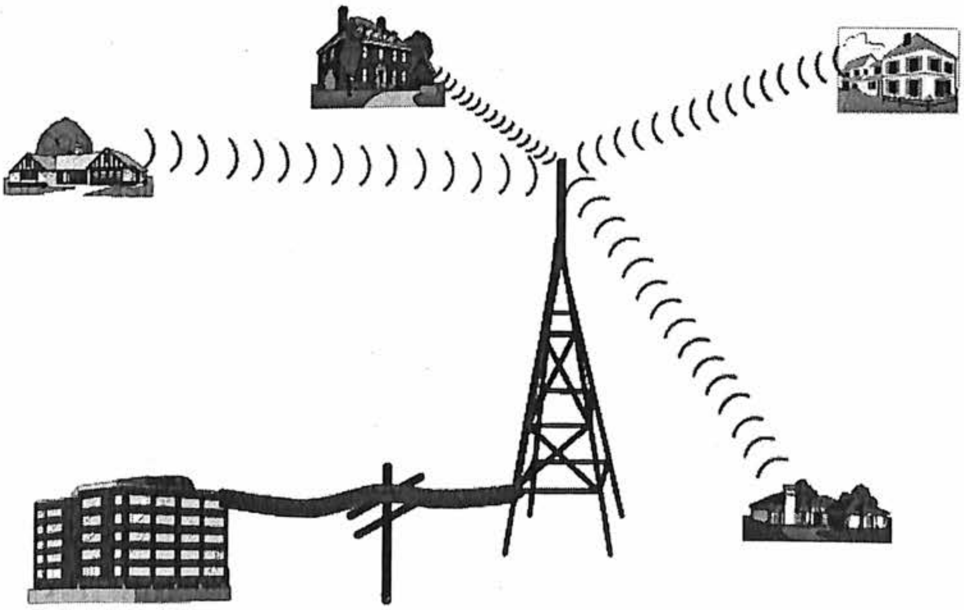


Fig.4: One way Fixed base AMR

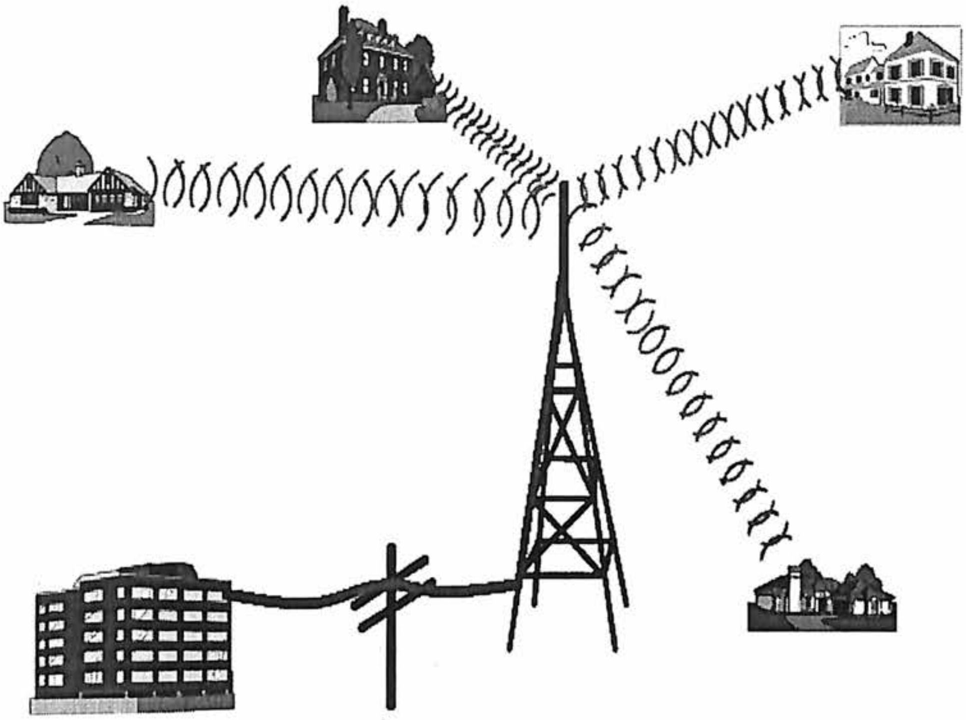


Fig.5: Two way fixed base AMR

System Benefits:-

• Multiple reads per day provided – Two-way meters accessed at any time.

• Improves utility meter reading efficiencies.

– Eliminates or minimizes final reads (move ins/outs).

– Utilize soft turnoffs – monitor usage at unoccupied site.

– Enhanced customer service – daily reading data.

• Eliminates or greatly minimizes readverifications.

• TOU readings/ Interval data.

• Positions utility as innovative and customer serving - give customer access to daily reads through Internet.

This type of AMR system is commonly used and will be discussed briefly.

Some type of telecommunications system is necessary to transfer the data in the meter to the central utility computer systems, and these systems may be wired or wireless. Most AMR systems are one-way, with meter data communicated to the utility, but some AMR systems provide two-way communication to allow polling of the meter and/or remote reprogramming of the MIU(Meter Interface Unit).

4.6. Power line AMR Systems:-

Operation:-

- Need link to electric utility distribution network.

- Gas meters usually linked to the electric network via a meter interface inside an electric meter.

- Gas meter link can be wired or wireless to electric meter.

- Meter reading data goes through electric network infrastructure to host computer with AMR software.

- Two types of electric based power line systems.

– One-way – electric meters programmed to transmit to the system host computer at a determined time interval.

– Two-way – electric meters can be "pinged" from the host computer requesting reading data or even provide a meter command for another function.

- Gas meter link usually one-way to electric meter and battery powered.

System Benefits:-

- Possible opportunity for combo electric/gas utility.

- Read both meters via the utility's existing infrastructure.

- Daily or more frequent meter readings – Meter can be accessed at any time.

- Works with both outbound and inbound systems.

- Improves utility meter reading efficiencies.

– Eliminates or minimizes final reads (move ins/outs).

– Utilize soft turnoffs.

– monitor usage at unoccupied site.

– Enhanced customer service – daily reading data.

- Eliminates or greatly minimizes re-read verifications.

4.7. Hybrid AMR Systems: -

Definition: A combination of two or more of the previously defined AMR systems that meet the business objectives of the utility that has installed them.

• Most likely solution for utility with wide reaching service territory – dense to sparse.

• Most likely for a large utility with more than one operating subsidiary which require different AMR systems.

• Will happen with a utility that changes from or adds a different AMR system to an existing AMR system.

System Benefits:-

• Different systems address utility's service needs – residential and C&I (Commercial and Industrial).

• Provide utility with the meter reading data needed.

• Optimize meter reading processes to maximize utility's operating efficiency objectives.

Before Discussing AMR in brief we should have a insight of different aspects of City gas Pipeline system

Pressure regimes for Distribution Networks:-

Sr.No	Network Component	Inlet From	Inlet Pressure	Outlet Pressure	Outlet to
1	CGS	Transmission line	49-28 barg	26 barg	Steel Grid
2	Steel Pipeline	CGS	26 barg	26-17 barg	DRS/CNG
3	DRS	Steel Pipeline	26-17 barg	4 barg	MDPE Pipeline
4	MDPE Pipeline	DRS	4 barg	4-1 barg	Industrial MRS &DRS
				1.5 barg	
5	Industrial MRS	MDPE Pipeline	4- 2 barg	1.5 barg or customer specific	Industrial internal Pipeline
		Steel Pipeline	26-17 barg	pressure within the supply range	

Table.1: Pressure regimes in City Gas Distribution

Conventional metering types includes: -

Type of Meter	Consumer Area	Range(SCMH /customers)
Diaphragm meters	Domestic and Commercial.	0 -23.
Rotary Positive Displacement meters	Medium to large commercial.	0 -750.
Turbine/ Orifice meters	Very large	110 - 2800 industrial Customers

Table.2: Types of meters and there Range.

Flowmeter's installed at various consumer places: -

Meter Type	Turdown Ratio /Rangeability	Max. Pressure	Max m3/hr
PD meter	1:160	0.5 bar	160 m3/hr
RPD meter	1:100	18 bar	1000 m3/hr
Turbine meter	1:30		16000 m3/hr

Table.3: Flow meters and max Flow

Chapter 5

AMR Components

Any Automatic Meter Reading or Real Time Metering system consists of the following three primary components:

5.1 Meters with communication Interface

5.1.1 Gas Flow meters.

5.1.2 Electronic Gas Volume converters.

5.1.3 Modem.

5.2 Communication System.

5.3 Central data collection system.

5.1 Meters with communication Interface :-

Meter interface module with **power supply, meter sensors, controlling electronics and a communication interface** that allows data to be transmitted from this remote device to a central location. In many instances, this communication interface is **bi-directional** and allows central office signals to be received by the remote unit as well. Every electric, gas or water meter must have such an interface unit to be remotely read. Some key components of the remote device may be **shared** by more than one meter without regard for the type of meter; i.e., **electric, gas or water**.

Meter Interface unit is used to capture data from the meter and transmit to host facility by suitable communication system. The communication Interface will be discussed in brief in the coming chapters.

Common types of Meters used for Gas metering. An overview of types and capabilities, plus guidelines on selection of meters are given below.

The flow rate is determined inferentially by measuring the liquid's velocity or the change in kinetic energy. Velocity depends on the pressure differential that is forcing the liquid through a pipe or conduit. Because the pipe's cross-sectional area is known and remains constant, the average velocity is an indication of the flow rate. The basic relationship for determining the liquid's flow rate in such cases is:

$$Q = V \times A$$

Where

Q = liquid flow through the pipe

V = average velocity of the flow

A = cross-sectional area of the pipe

Other factors that affect liquid flow rate include the liquid's **viscosity** and **density**, and the **friction of the liquid** in contact with the pipe.

Direct measurements of liquid flows can be made with positive-displacement flowmeters. These units divide the liquid into specific increments and move it on. The total flow is an accumulation of the measured increments, which can be counted by mechanical or electronic techniques.

5.1.1 GAS FLOWMETER TYPES :-

Numerous types of flow meters are available for closed-piping systems. In general, the equipment can be classified as below:

1. **Differential Pressure Meter's.**
2. **Positive displacement Meter's.**
3. **Velocity Meter's.**
4. **Mass Meter's.**

Differential pressure devices include:

- **Orifice Meters***
- Venturitubes .
- Flow tubes.
- Flow nozzles.
- Pitot tubes.
- Elbow-tap Meters.

Positive displacement meters include

- **Piston type***
- **Rotary-vane types***
- Oval-gear.
- Nutating-disk type.

Velocity meters include

- **Turbine***
- Electromagnetic.

Mass meters include:

- **Coriolis***
- Thermal types.

Differential Pressure Meters :

The basic operating principle of differential pressure flow meters is based on the premise that the pressure drop across the meter is proportional to the square of the flow rate. The flow rate is obtained by measuring the pressure differential and extracting the square root.

Differential pressure flow meters, like most flow meters, have a primary and secondary element. The primary element causes a change in kinetic energy, which creates the differential pressure in the pipe. The secondary element measures the differential pressure and provides the signal or read-out that is converted to the actual flow value.

Orifice Meter:

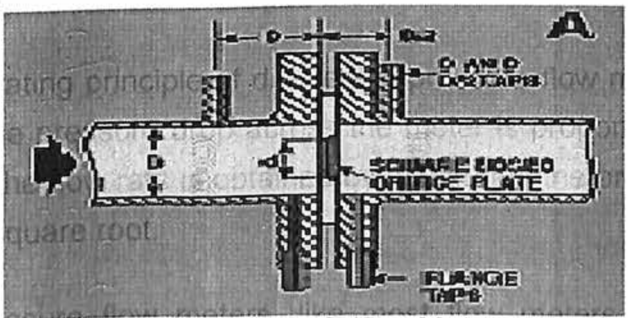


Fig.6: Orifice Meter

Orifices are the most popular liquid flow meters in use today. An orifice is simply a flat piece of metal with a specific-sized hole bored in it. Most orifices are of the concentric type, but eccentric, conical (quadrant), and segmental designs are also available.

In practice, the orifice plate is installed in the pipe between two flanges. Acting as the primary device, the orifice constricts the flow of liquid to produce a differential pressure across the plate. Pressure taps on either side of the plate are used to detect the difference. Major advantages of orifices are that they have no moving parts and their cost does not increase significantly with pipe size.

Metering accuracy of all orifice flow meters depends on the installation conditions, the orifice area ratio, and the physical properties of the liquid being measured.

Positive-Displacement Meters:-

Operation of these units consists of separating liquids into accurately measured increments and moving them on. Each segment is counted by a connecting register. Because every increment represents a discrete volume, positive-displacement units are popular for automatic batching and accounting applications. Positive-displacement meters are good candidates for measuring the flows of viscous liquids or for use where a simple mechanical meter system is needed.

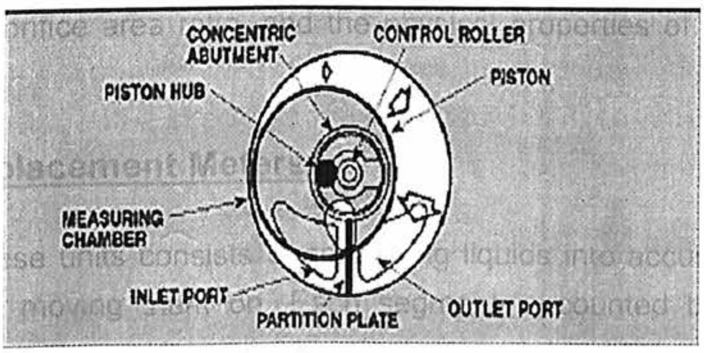


Fig.7: PD Meter

Oscillating Piston Meter operates on a magnetic drive principle so that liquid will not come in contact with parts. A partition plate between inlet and outlet ports forces incoming liquid to flow around a cylindrical measuring chamber and through the outlet port. The motion of the oscillating piston in the unit is transferred to a magnetic assembly in the measuring chamber, which is coupled to a follower magnet on the other side of the chamber wall.

Reciprocating piston meters are of the single and multiple-piston types. The specific choice depends on the range of flow rates required in the particular application. Piston meters can be used to handle a wide variety of liquids. A magnetically driven, oscillating piston meter is shown in Fig. 7. Gas never comes in contact with gears or other parts that might clog or corrode.

Rotary-vane meters are available in several designs, but they all operate on the same principle. The basic unit consists of an equally divided, rotating impeller (containing two or more compartments) mounted inside the meter's housing. The impeller is in continuous contact with the casing. A fixed volume of gas is swept to the meter's outlet from each compartment as the impeller rotates. The revolutions of the impeller are counted and registered in volumetric units.

Velocity Meters:

These instruments operate linearly with respect to the volume flow rate. Because there is no square-root relationship (as with differential pressure devices), their Rangeability is greater.

Turbine meters:

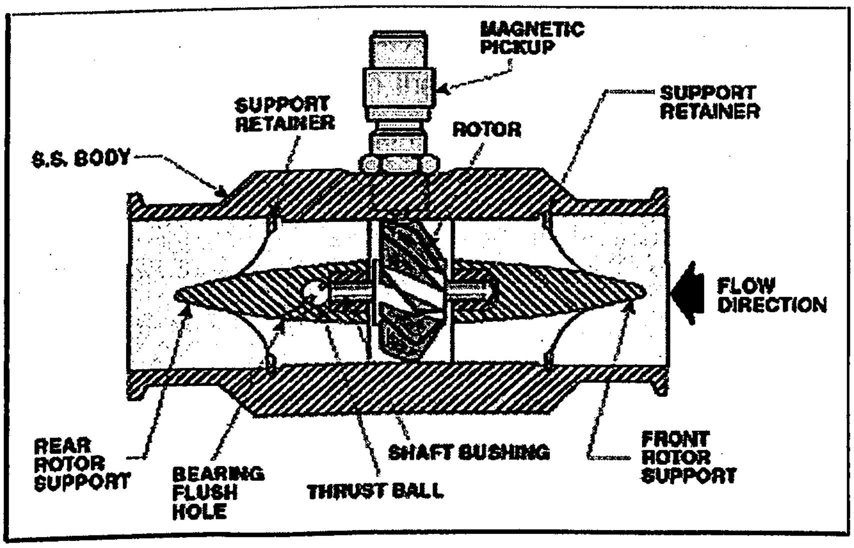


Fig.8: Turbine meters

Turbine meters consists of multiple bladed free spinning permeable metal rotor housed in non-magnetic stainless steel body. In operation the rotating blades generate a frequency signal proportional to gas flow rate which is sensed by a magnetic pick up and send out to a read out indicator.

The number of electrical pulses counted for a given period of time is directly proportional to flow volume. A tachometer can be added to measure the turbine's rotational speed and to determine the liquid flow rate. Turbine meters, when properly specified and installed, have good accuracy, particularly with low-viscosity liquids.

Mass Flow meters:

The continuing need for more accurate flow measurements in mass-related processes (chemical reactions, heat transfer, etc.) has resulted in the development of mass flowmeters. Its operation is based on the natural phenomenon called the Coriolis force, hence the name.

Coriolis meters:

They are true mass meters that measure the mass rate of flow directly as opposed to volumetric flow. Because mass does not change, the meter is linear without having to be adjusted for variations in liquid properties. It also eliminates the need to compensate for changing temperature and pressure conditions. The meter is especially useful for measuring liquids whose viscosity varies with velocity at given temperatures and pressures.

Coriolis meters are also available in various designs. A popular unit consists of a U-shaped flow tube enclosed in a sensor housing connected to an electronics unit. The sensing unit can be installed directly into any process. The electronics unit can be located up to 500 feet from the sensor.

Inside the sensor housing, the U-shaped flow tube is vibrated at its natural frequency by a magnetic device located at the bend of the tube. The vibration is similar to that of a tuning fork, covering less than 0.1 in. and completing a full cycle about 80 times/sec. As the liquid flows through the tube, it is forced to take on the vertical movement of the tube, Fig.. When the tube is moving upward during half of its cycle, the liquid flowing into the meter resists being forced up by pushing down on the tube.

Vibrating U-shaped is the heart of popular coriolis mass flow meter. Tubes vibration coupled with fluids force causes tube deflection that is directly proportional to mass flow rate.

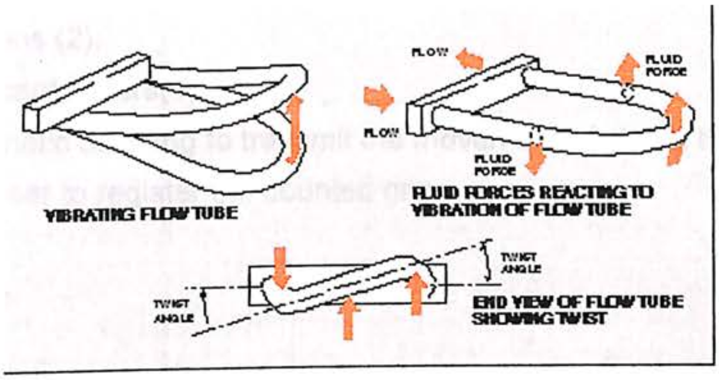


Fig.9: Coriolis Meters

Having been forced upward, the liquid flowing out of the meter resists having its vertical motion decreased by pushing up on the tube. This action causes the tube to twist. When the tube is moving downward during the second half of its vibration cycle, it twists in the opposite direction. The ammount of twist is directly proportional to the mass flow rate of the liquid flowing through the tube. Magnetic sensors located on each side of the flow tube measure the tube velocities, which change as the tube twists. The sensors feed this information to the electronics unit, where it is processed and converted to a voltage proportional to mass flow rate.

Rotary Delta Meters (C&I)

Fig.10 Rotary Delta Meter

Operating Principle:

Delta Meters are Volumetric Meters. The Flow of gas moves 2 pistons and each rotation traps and transfers a specific volume of gas. The measured gas volume is registered in the totaliser and transmitted via a mechanically transmitted to the totaliser through the magnetic coupling.

Description:-

- A Delta meter is made up of five main parts
- A measuring chamber that is limited by the body and two base plates (1).
- 2 pistons which are synchronized by 2 gears and which rotate in opposite directions (2).
- 2 lubricant covers(3).
- A magnetic coupling to transmit the movement of piston to totaliser (4).
- A totaliser to register the counted gas.

Application:-

Delta meters are designed to measure natural gas and various filtered and non corrosive gas. They are used when very accurate measurement is required ,when the gas flow is low or irregular. Due to volumetric principle of delta meter, its metrology is not influenced by installation conditions. Consequently it can be used to build very compact stations without installing a straight pipe inlet before the meter.

Delta meters are approved for fiscal use.

Technical Specifications:-

Flow rate	From 0.4 m3/h to 1000 m3/h
G size	G10 to G 650
Nominal Diameter	From DN 40 to150mm
MaximumWorking Pressure	Upto 94Bar depending on body material and flanging.
Temperature Range	Ambient -20°C to 60°C Gas -20°C to 60°C Storing Temp. -40°C to+70°C
Rangeability	1:20 to 1:50
Flanging	PN 10/16,PN20 and ANSI 125
Pulse Transmitter	Retrofittable LF-system, 12 Vdc max 10 mA max. standard 0.01 m3/pulse, 0.1 m3 / pulse or 1m3 / pulse upon request.

Table.4 Specifications of Rotary Delta Meter

Diaphragm Gas Meter:-

The Diaphragm Meter a very compact residential gas meter designed to measure accurately volumes of natural gas, LPG and all non-corrosive gases.

Operating Principle:-

The Diaphragm Meter is a positive displacement diaphragm meter with a built-in twin- chamber measuring unit. Each chamber is equipped with a flexible, gas-tight diaphragm, which is displaced by the differential between the inlet and outlet pressure. The gas enters one side of the diaphragm pan while on the other side it comes out through a separate port on the valve. When one side is full, the rotating mono-valve moves on to the next position, allowing gas to fill the empty side. The movement of the diaphragm is transferred via a gear to the corresponding crankshaft .The shaft drives the slides which control the gas flow.

A transmission gear and a mechanical stuffing box transfer the reciprocating motion to the mechanical retrofittable index.

The rotations of the gear are transferred via magnetic coupling to the index.
The flange construction enables an easy installation of the meter in the piping.

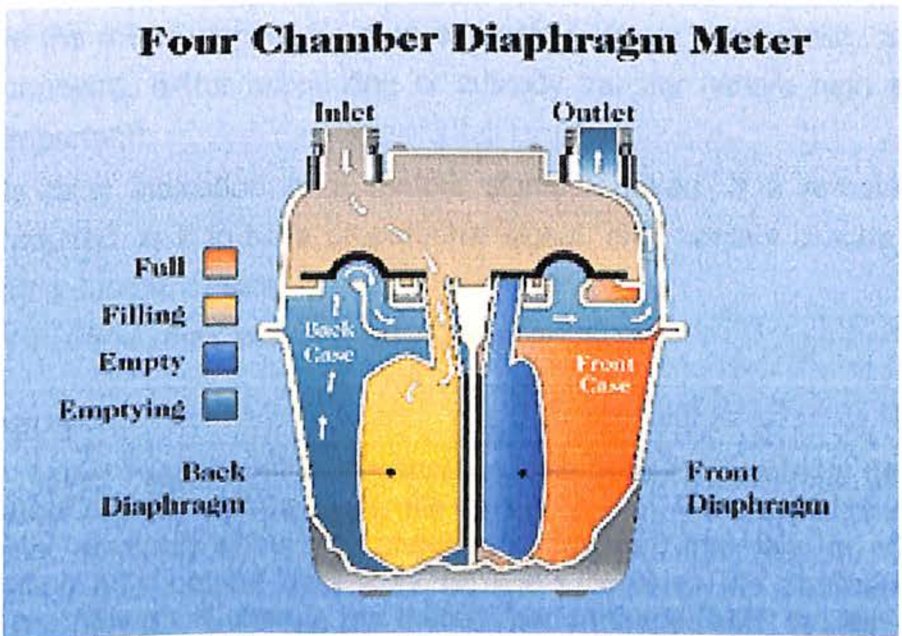


Fig.11 Diaphragm Meter Operating Principle

The measuring unit is housed in a gas-tight, aluminium casing.

Technical Specifications:

Gas Type	Natural gas, LPG and all non-corrosive gases
Cyclic Volume	0.7 dm3
Operating Temperature	- 20°C to + 50°C
Storage Temperature	- 40°C to + 60°C
Maximum Operating Pressure	1.5 bar
Measuring Range	Qmin - 0.016 m3/h Qmax - 3 m3/h
Pulse Generator	Standard 0.01 m3 / pulse Optional 0.1 m3 / pulse or 1 m3 / pulse
Pulse Transmitter	Retrofittable LF-system, 12 Vdc max 10 mA max, standard 0.01 m3/pulse, 0.1 m3 / pulse or 1m3 / pulse upon request. Wire fixation by jack plug or connecting block
Casing Material	Aluminium with aluminium or steel shells
Connections Threads	ISO228 standards M26 x 1.5;M30 x 2;7/8" G3/4"G1"1/4;NPT;BS746 Other connections on request.

Table.5 Specifications for Diaphragm Meter

SELECTING A FLOWMETER :

The most important requirement is knowing exactly what the instrument is supposed to do. Following are the conditions for selection of meter.

- Is the measurement for process control (where repeatability is the major concern), or for accounting or custody transfer (where high accuracy is important).
- Is local indication or a remote signal required, If a remote output is required, is it to be a proportional signal, or a contact closure to start or stop another device.
- What flow rates are involved in the application.

Calibration

All flow meters require an initial calibration. The need to recalibrate depends to a great extent on how well the meter fits the application. If the application is critical, flow meter accuracy should be checked at frequent intervals. In other cases, recalibration may not be necessary for years because the application is non-critical, or nothing will change the meter's performance. AMR system provides a tool on Consumption Profiles so that utility gets to know the order of recalibration of meters.

Maintenance

A number of factors influence maintenance requirements and the life expectancy of flow meters. The major factor, of course, is matching the right instrument to the particular application. Poorly selected devices invariably will cause problems at an early date. Flow meters with no moving parts usually will require less attention than units with moving parts. But all flow meters eventually require some kind of maintenance.

Communication Interface

These are commonly referred to as implant modules. Such an implant module has an internal power supply, sensor, processor, and communications interface such as a telephone modem or radio transmitter.

5.1.2 Electronic Gas Volume Converter:-

Locally mounted **EVC transmits the stored data to Data collection units termed as Remote Terminal Unit.**

Gas correctors are field devices that narrowly target gas metering. The automation logic and I/O capabilities of these devices are specifically tailored to performing gas metering calculations in compliance with standards that are sanctioned by AGA, American Gas Association. The AGA calculations compensate for the changes in density that occurs when a gas changes temperature and pressure.

In addition to the AGA calculations federal and state regulatory agencies require that gas metering devices store the raw data that is used in the density calculation for 30 days. This archived data is made available to host computers through the telemetry system for the purpose of auditing the calculations performed by the metering device.

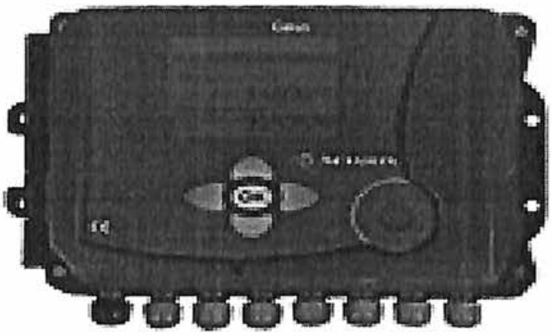


Fig.12 EVC

The EVC is a key element in the whole AMR chain, from the meter to the billing data, because it **converts** the **actual volume** measured by the gas meter to **reference conditions**. It provides extremely accurate measurement over the whole temperature and pressure range and many advanced functions including a graphic display, a large integrated database and various remote-reading solutions through PSTN or GSM solutions.

The volume registered by the meter is converted to reference conditions by using the following formula

$$\mathbf{V_b = (P_m/P_b) * (T_b/T_m)*(Z_b/Z_m) * V_m}$$

Where,
V_b = Converted volume into reference (base) conditions
V_m = Unconverted volume registered by meter
P_b = reference (base) pressure
P_m = Gas pressure in operating conditions
T_b = reference (base) temperature
T_m = Gas temperature in operating conditions
Z_b = Compressibility factor in reference (base) conditions
Z_m = Compressibility factor in operating conditions.

Key Features

- T, PT, PTZ gas volume converter
- Battery or external supply mode
- Pressure range:
    - 0.9 / 10 bar abs.
    - 7.2 / 80 bar abs.
- Low frequency input (2Hz max)

This electronic volume converter dedicated to commercial and industrial applications. It converts the actual volume measured by the gas meter to reference conditions. It uses the measured working values of volume, pressure and temperature to provide:

- Converted Volume
- Conversion Factor
- Compressibility Factor
- A large Database
- Pulse Retransmission

This EVC is mounted on the meters itself which in turn is connected to Modem.

Specifications for EVC:-

Overall Accuracy of C factor	Maximum Error < 0.5%
Conversion Range	Pressure:0.9 to 80 bar – Temperature according to Z formula
Power supply	Batter or External
Ambient Temperature range	-25° C to +55°C
Volume Input	LF input(Max 2 Hz), Reed switch type
Temperature Sensor	PT 1000 Class A, 4 wires
Pressure sensor Range	0.9/10 bar 7.2/80 bar
Pressure Sensor type	Piezo-resistive sensor
Outputs	2 channels fully configurable as pulse/alarm
Communication	Optical Serial port and RS-232 serial Port
Option	Internal PSTN Modem

Table.6: Specifications of EVC

Benefits

- High accuracy over the whole pressure & temperature range
- Possibility of downloading a new firmware in the field
- Graphic display
- Many communication options

Fig.13 Meter mounted with EVC

5.1.3 Modem:-

Fig.14 GSM Modem

There are various types of modems, which are used for AMR and other control applications:

1. Modem: A GSM, GPRS or PSTN modem attached to the meter, which is polled by the central AMR billing system using a serial Automatic Meter Reading protocol e.g. IEC 1107.

2. I/O Modem: In addition to simple modem features, the status of other equipment such as compressors can be monitored e.g. temperature and on/off status. This offers simple I/O monitoring telemetry and SMS alarm alerting functions to complement the AMR function at system level.

3. TCP/IP modem: Beyond traditional automatic meter reading modem functionality, the Internet can be used to deliver data to 3rd party applications using E-mail, FTP and Internet protocols.

Description:-

The **modem** can be **connected** to an electronic device such as a **EVC** or data Logger in an hazardous area, through a **RS-232** serial port. The Modem manages a "time windows" in which the GSM terminal modem is activated by itself. The converter or the data logger is reached via this "time windows" by a remote reading software. This function not only allows frequent periodical readings but also provides an important autonomy.

The internal battery has a lifetime of **three years** with a weekly reading and a 30 mn "time windows" per week. When the battery lifetime is lower than 5% its nominal value, an output is activated. This output can be connected to material in hazardous areas (digital input of the converter) and the status of the input is collected during the next remote reading of the converter.

Technical Specifications:-

General	Dual Band GSM 900/1800 MHz
	Support data SMS, Voice and Fax
	Max Power o/p: 2 W (900 MHz), 1W(1800 MHz)
	Group 3 Fax Support
	GPRS Class B Class 2(28.8 download/ 14.4 Kbps upload) at maximum speed.
	AT command set (GSM 07.05, GSM 07.07)
Approval	Ex approval for safe area installation and connection with a device in hazardous areas.
Environment	Operating temperature range: - 20°C to + 50°C. IP 66 Enclosure.
Antenna	Internal or external
Power supply	*Autonomous or external: *Autonomous: lithium battery type: typical 3 years autonomy with a weekly reading. *External power: through a specific intrinsic safe supply module. *Input Voltage: 5 to 32V DC *MAX current at 5 V: 450 mA in Commn. 2.5A in Commn. *35 mA in idle mode. *13 mA in idle mode with RS-232 power saving.

Features	*Automatic reset in case of communication error. *Battery alarm output. *2 barriers for pulse retransmission from hazardous area to non-intrinsically safe devices in safe area *RS 232 serial port. *Optical port for local configuration.

Table.7: Technical Specifications for GSM Modem

- A specific external power supply module provides a solution with a permanently active modem (without "time windows").
- The IP 66 enclosure and the industrial temperature range make installation easy in the field, without a cabinet. However, installation in direct sunlight is not advised.
- The internal antenna can be replaced with an external one, in case of bad reception in the installation area.
- The optical port of the Modem is used for the configuration, but it is also possible to configure the Modem remotely, via the modem.
- The Modem can be also used as an isolation barrier for 2 digital signals coming from the hazardous area.
- The pulse volume outputs of the converter can be collected this way to a RTU (which is not approved for intrinsic safety) in a safe area.

5.1.4 Remote Terminal Units:-

RTU also called as data collection unit collects the data from meters through GSM modem interface with EVC at remote place by GSM Towers

- RTU based systems shall interface with local field Instruments, Flow Computers at metering stations, DRS, Sectionalizing Valve stations.

- Function as data concentrator to streamline the communication between the SCADA host server and the field devices.

- Perform system monitoring and self-diagnostics to detect failure conditions and take appropriate actions such as switching to a back up devices and for generating an alarm to the SCADA host servers.

- Mutidrop/point to point communication LAN (Ethernet over TCP/IP or DNP) between the RTU s and MCC, SMCC, LCC (n*64KBPS).the back up communication route of PSTN / n*64kbps Leased line.

- Communication between RTU and down stream field devices and intelligent instruments will be done via leased line, PSTN, GSM module.

- Serial data links for communication to the RTU shall be dual redundant at each location.

- Each control centre shall be equipped with at least one high end RTU.

RTU Specification's: -

Software Specification's: -

Control	Two PID control loops, output calculated every second.
Serial Communication Interface	Two RS-232 asynchronous serial ports expandable up to four or six one port for RS-232Cand one port for DNP 3.0(slave)
Communication Protocol	Modbus ASCII, Modbus RTU
Lan Protocol	TCP/IP Modem, I/O Modem
Field Protocol	Modbus
Communications Options	Bell Model 103, 202, or 212 modem. Digital radio with integral modem (900/1800-Mhz).

Table.8: Software Specifications

Hardware Specifications:-

Analog Inputs	Eight (one analog input can be jumpered for direct 100-Ohm platinum RTD input)
Range	Nominal 0- to 5-Vdc, 1- to 5-Vdc, 0- to 25-mA or 4- to 20-mA (jumper selectable)
Resolution	12-Bit, unipolar
Accuracy	Current inputs ±0.1% of full scale, voltage inputs ±0.1% of full scale (including linearity, hysteresis, repeatability, and resolution)
Temperature coefficient	±0.01% of full scale/degree F
Analog Outputs	Two
Range	0- to 25-mA or 4- to 20-mA
Resolution	12 bit unipolar
ADC	12 bit
CPU	16/32 bit
Accuracy	±0.1%, firmware calibratable to ±0.1% (including linearity, hysteresis, repeatability, and resolution)
Digital Inputs	Eight inputs @ 4- to 32-Vdc, 2-Hz maximum, 2-mA current limited (firmware filtered)
Optional	Turbine meter prescaler accepts up to 5-Khz signals from turbine meter
Digital Outputs	Eight outputs @ 0.5-Amp continuous, 6-Amp pulsed, 32-Vdc maximum
Data Ports	Two RS-232 asynchronous serial ports (1 for MMI, 1 for 300- to 19.2-KBaud telecommunications)
	Expansion ports provide RS-232 or RS-485 interface to external instruments and/or controllers

Table.9: Hardware Specifications

Interfacing of different components with central utility System:

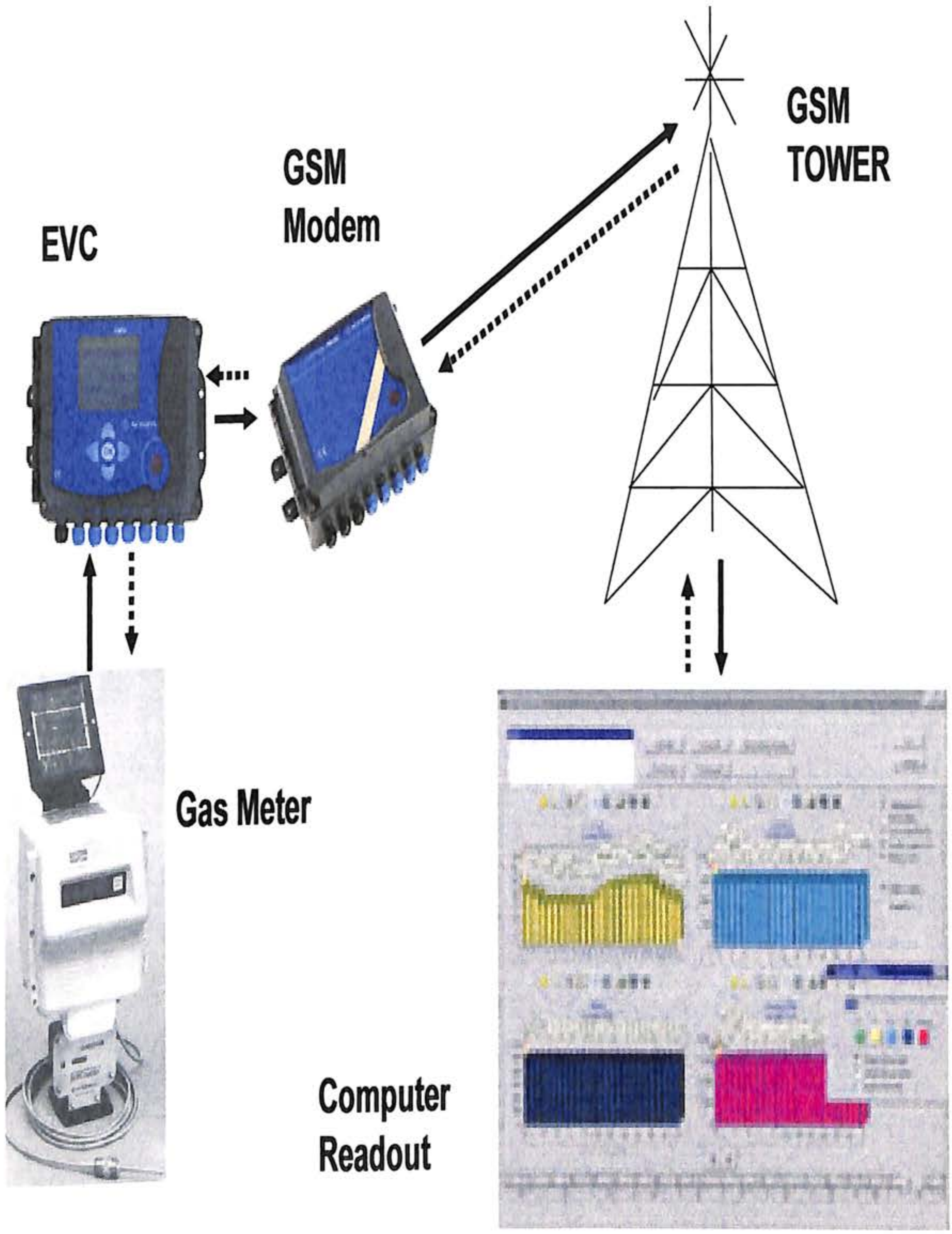


Fig.15:Interfacing of Different components in AMR

Radio Data Logger:

A radio data logger or data concentrator here used as a RTU or sometimes termed as Data Collection Unit is a device that collects data from distributed processes using a wireless technology rather than cables. In the energy monitoring example given below there are a number of water meter's, gas meter's, electricity meter's communicating with radio data logger via a wireless medium. This Radio data logger communicate over a distance from 200m to 10Km. Data can be extracted from the logger via a variety of media which depending upon the type of communication includes GSM dial, PSTN dial, SMS text, HTTP, FTP, e-mail and much more. Also RTU to RTU communication is possible.

The GSM Modem is an autonomous industrial radio modem designed for remote reading purposes for electronic devices in the gas industry. Compact, reliable and intrinsically safe, it can be linked directly to an Electronic volume converter or data logger with data being collected through software installed at central hosting system, using the Windows environment.

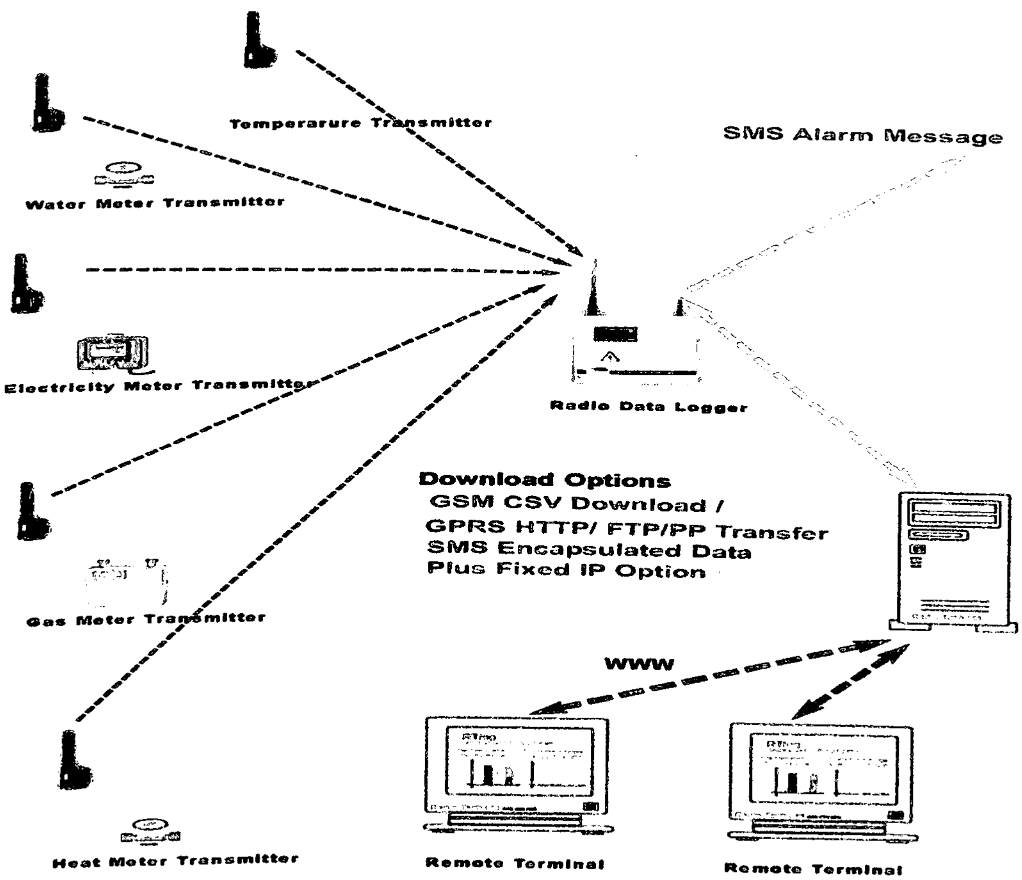


Fig.16 Data Logger

5.2 Communications System:-

A communications system or network is required for the **transmission** or remote telemetry of data and control signals between the **customer's meters** and the **utility** company. Typically such communications takes the form of telephone, power line carrier, radio frequency, cellular telephone, pager network, or low earth orbit satellite or hybrid of above. The ideal communications media will be transparent to the service subscriber, bi-directional, and always available from either the meter or utility end of the loop. It must be readily available throughout the utility service area and low cost in terms of transaction fees or inexpensive to install and maintain if independent from a public access communications network. Modes of communication are discussed breifly

1. **Telephone lines** -Telephone lines are desirable from an economic point of view since most electricity users in the country have telephone service. The telephone system provides an ideal communication infrastructure for AMR systems due to simplicity of operation, quality of data, high noise immunity, reliability and low cost, both at the remote site and the central station.

Telephone communications AMR systems are categorized by the method of call initiation and initial data flow.

The two most common forms are

- *Inbound communications* - A unit at the customer site (usually the controller or a modem connected to the controller) dials in to the central station system at the utility without first receiving an interrogation message.
- *Outbound communications* - Data communications are initiated by a central unit located at the utility or at a local telephone company switching station.

2. **Power line carrier** - Power line carrier communications take place over the same lines that deliver electricity. This technique involves injecting a high frequency AC carrier onto the power line and modulating this carrier with data originating from the remote meter or central station.

3. Cable Television Communication - This communication approach uses existing cable television lines to transmit data. Future advances in cable will include bi-directional digital signal transmission and much wider bandwidth ultimately using fiber optics at which point cable will be an ideal communications medium.

4. Radio frequency - Radio frequency, or RF, systems make use of small low power RF transmitters or transceivers located at the controller of meter. These may take advantage of licensed or unlicensed portions of the RF spectrum and the effective radiated power of the transmitter and the distances capable of being traversed will vary as a function of the frequency and power of the remote transmitters and the receiving strategies employed. The most successful employs a mobile unit operated in a van that sends a wakeup and transmit command to the remote meter units in its range. The remote meter units pick up the signal and respond by sending back requested data to the van's computer for later uploading and billing. This system is commercially available for use with gas meters. Two of the more exotic approaches involves use of a cellular telephone network system and satellite communications.

Advantages of RF-based AMR systems:

- Operate on a single frequency.
- Easier to design and use less expensive components.
- Supports Mesh Networks.

Disadvantages of RF -based AMR systems:

- High Operational Expenses
- Per consumer bill does not support GSM Technology except large consumers such commercial and Industrial customers.

In our Project we are using Radio Frequency Technology for which GSM Tower's called as **Tower Gateway Base** stations are erected at **different Local Control center's** where District Regulating Stations are present which is linked with Remote Terminal Unit, which combines to form a Regional Network Interface, which uses **Direct Sequence Spread Spectrum** (DSSS) Technology.

5.2.1 Direct Sequence Spread Spectrum (DSSS) Technology:-

The technology used in the fixed network transmitters, receivers and NTR(Network Transceiver and Receiver) is Direct Sequence Spread Spectrum (DSSS), a technology derived from military applications and known for robustness, radio link reliability and high immunity to noise and interference.

An encoded signal is spread over a large bandwidth, transmitted and then received and decoded at the receiver technology provides superior long range of communication, while maintaining extremely low overall power consumption.

The network uses the **902-928 MHz** unlicensed operation.

Spread Spectrum uses wide band, noise-like signals. Because **Spread Spectrum signals are noise-like, they are hard to detect.** Spread Spectrum signals are also hard to Intercept or demodulate. Further, Spread Spectrum signals are harder to jam (interfere with) than narrowband signals. These Low Probability of Intercept (LPI) and anti-jam (AJ) features are why the military has used Spread Spectrum for so many years. Spread signals are intentionally made to be much wider band than the information they are carrying to make them more noise-like.

Spread Spectrum transmitters use similar transmit power levels to narrow band transmitters. Because Spread Spectrum signals are so wide, they transmit at a much lower spectral power density, measured in Watts per Hertz, than narrowband transmitters. This lower transmitted power density characteristic gives spread signals a big plus. Spread and narrow band signals can occupy the same band, with little or no interference. This capability is the main reason for all the interest in Spread Spectrum today.

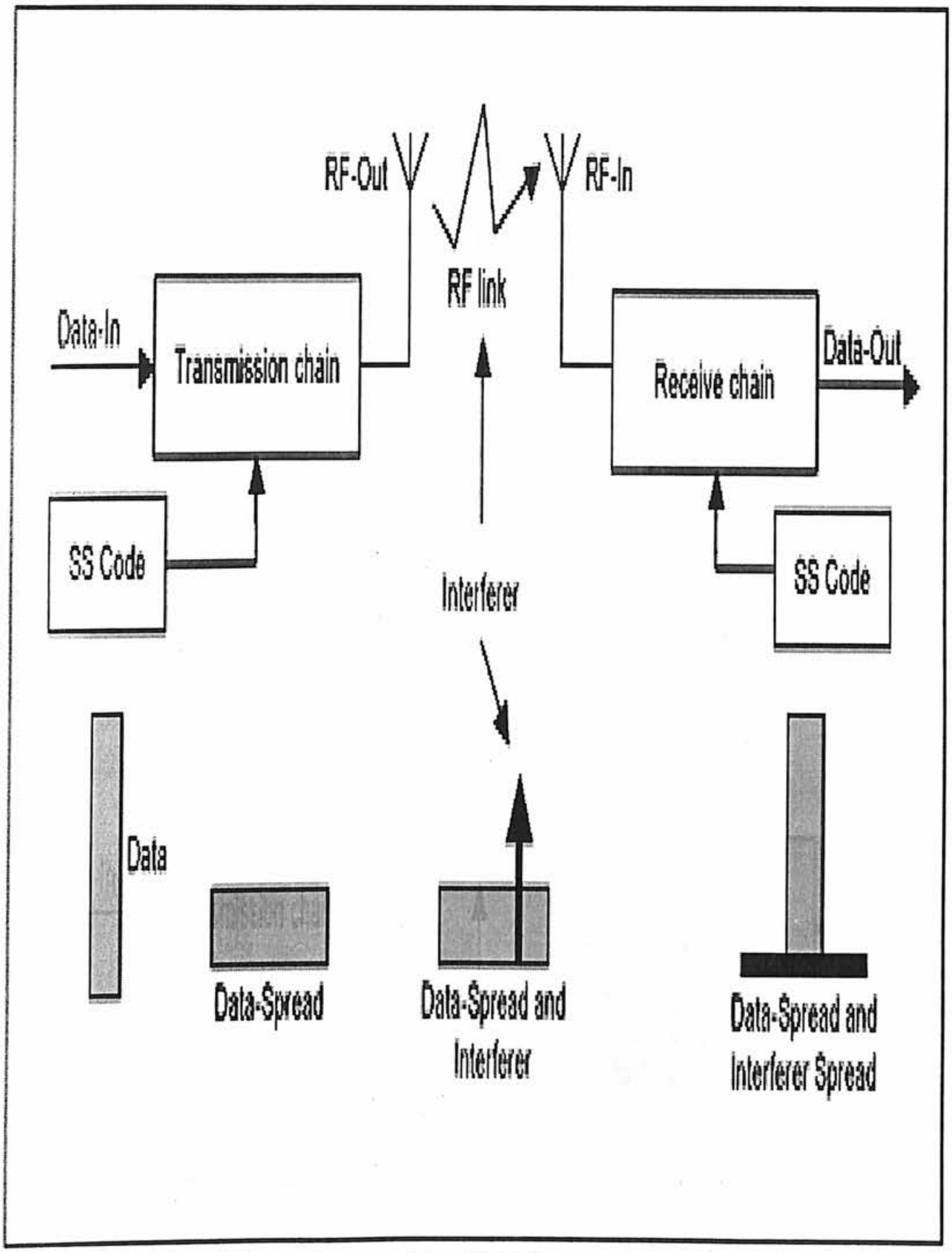

RF-Out
RF-In
RF link
Data-In
Transmission chain
Receive chain
Data-Out
SS Code
Interferer
SS Code
Data
Data-Spread
Data-Spread and
Interferer
Data-Spread and
Interferer Spread

Fig.17: DSSS

5.3 Central office or utility back office system:-

Central office systems equipment **include modems, receivers, data concentrators, controllers, host upload links, and host computer**. Many utilities have for some time been taking advantage of electronic meter reading systems using hand-held data terminals that communicate with a central controller via phone lines. There is great similarity between the host side electronic meter reading and automatic meter reading system function.

This refers to the communications equipment and computer systems at the utility office used to receive the data as sent over the communications network, store it in data base format, and interface it to the utility's billing and information systems.

Data collection system:

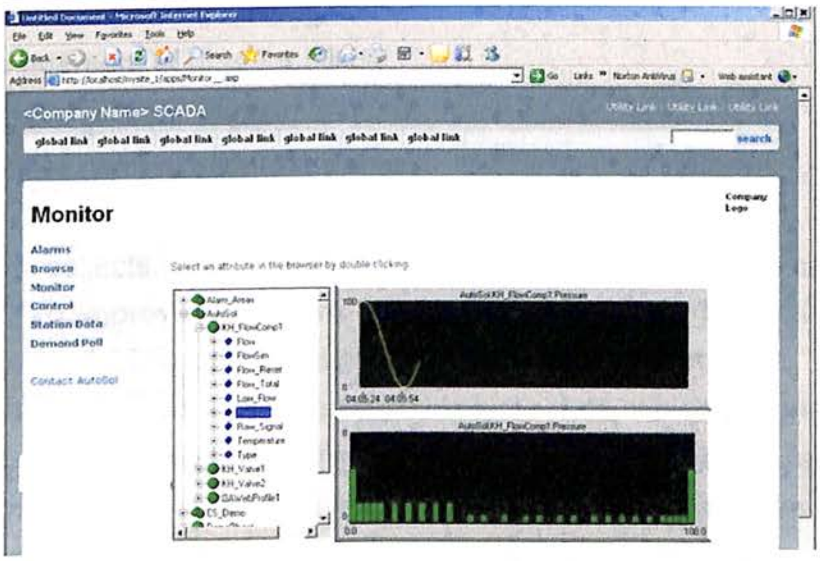


Fig.18 Monitoring / Trending of Gas Consumption

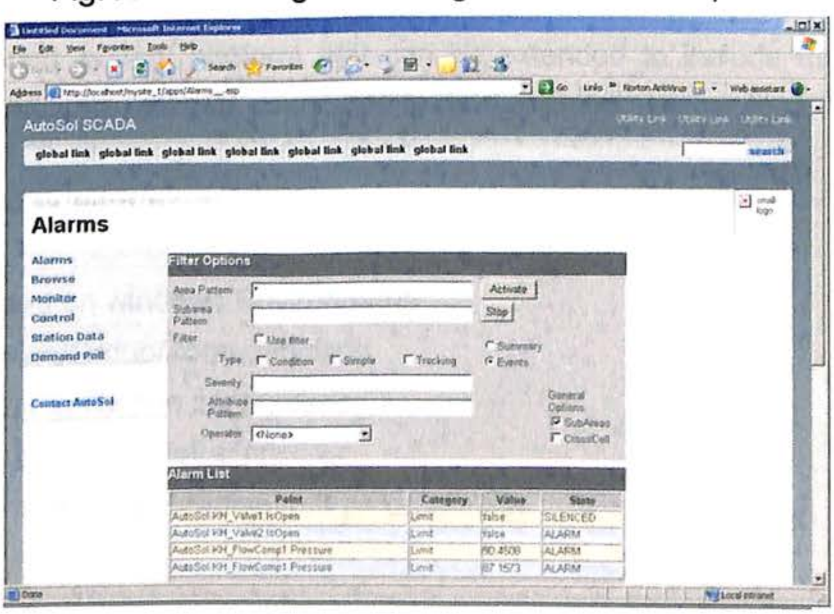


Fig.19 Details of Alarm Generation

Key Features

- Works under windows environment.
- Client/Server architecture.
- Up to 8 modems managed in parallel.
- Visualization through tables or graphs.
- SQL compatible Database.
- Remote/Local Data Reading.

Software of data collection system, facilitates automated acquisition of data from all commercial and industrial gas devices. Most often these **softwares are proprietary one** and are based on a modular architecture, offers many functionalities such as:

- Automatic remote reading.
- Management of data for billing.
- Graphic or table display.
- Remote configuration of devices.

The system collects data through PSTN or GSM Networks and can be flexibly scheduled. To improve operations efficiency, this software can manage multiple modems for collecting data through the PSTN or GSM networks. This software collects both converted and unconverted volume data, which can be visualized in the system with a powerful graphical interface. The meter status data is used by the system operator to monitor the metering devices. Data can be exported automatically or manually to utility billing systems or other software in ASCII format.

It is an open system platform that can be extended to include more metering devices and up to 5 clients connected to data collection server.

Main Specifications

- Based on windows Environment.
- Device/Group/Zone definition.
- Communication configuration.
- System Administration.
- Remote/local Reading and programming.

- Data visualization/summation.
- Event/Alarm logging.
- Automatic Database Backup.
- Data import/Export.
- Client/Server architecture with upto 5 clients connected to data collection server through LAN.

Software Capabilities:-

Integrated software for data collection, data transfer and load research of metered data. The software shall be able to handle a wide range of revenue meters from different Vendors.

The software is able to run on any standard IBM PC or compatible computer for stand alone applications to support data collection, validation, editing and data analysis.

Technical Specifications:-

- Machine PC Compatible.
- OS Microsoft Windows 95/98/NT/2000/XP.
- Pentium III 300 MHz or superior.
- 2GB Hard Disk Available.
- 128 Mbytes RAM.
- 1024 X 768 display.
- 1 CD-ROM Drive.
- 1 serial port available.
- Network environment such as Novell, Windows NT.

Data Collected:-

- Converted and unconverted volume.
- Instantaneous data.
- Event Log data.
- Alarms .
- Device Configuration.
- Analog Data (P & T).

Benefits:-

- Facilitates data collection for Commercial & Industrial range.
- User-friendly, provides a smart graphic tool giving clear visualization of data.
- A scheduler provides automatic data collection for many devices, with a programmable period.

Chapter 6

Network operation

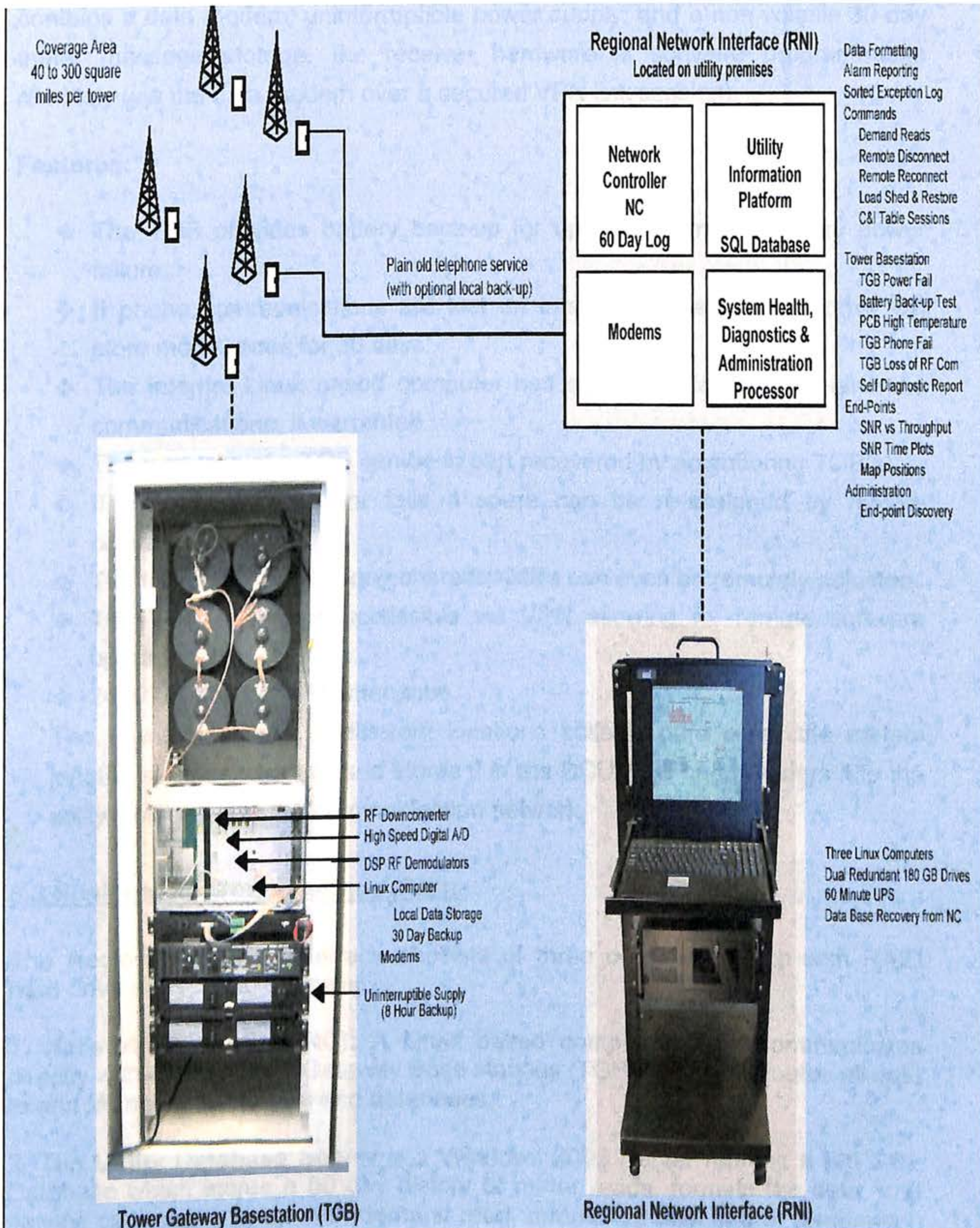


Fig.20: Network operation

6.1 Tower Gateway Base station (TGB):

The TGB consists of tower-mounted high-gain antenna, cavity filter, transceiver hardware, Digital Signal Processors and a Linux-based computer. The TGB also contains a data modem, uninterruptible power supply, and a non-volatile 30-day meter message storage. the receiver hardware is software programmable remotely (via the data modem over a secured VPN link session).

Features:

- The TGB provides battery back-up for up to 8 hours of primary power failure.
- If phone communications are lost an internal solid-state hard drive will store meter reads for 30 days.
- The internal Linux based computer has card slots for fallback land-line communications, if warranted.
- The total loss of a TGB can be in part recovered by neighboring TGB's.
- If a channel processor fails a spare can be re-assigned by remote command.
- The frequency and filtering characteristics can even be remotely adjusted.
- The TGB is remote accessible via VPN allowing for remote software upgrades.
- 24 X 7 X 365 Field Maintenance.

The towers installed at different locations collects data of all the meters located at different areas and stores it in the DCU/RTU and transfers it to the utility's offices over the communication network.

6.2 Regional Network Interface (RNI):-

The Regional Network Interface consists of three computers each with RAID hard drive arrays, and a firewall.

1. **Network Controller (NC):** A Linux based computer which communicates directly with all the Tower Gateway Base stations (TGB's). The NC routes all data to and from specific towers and databases.

2. The **Utility Database Server** is a Windows 2003 Server running a MS SQL Database which stores a 60 day history of meter reads, formats the data, and passes commands to the NC (demand read, remote connect and/or disconnect, load shed/restore and C&I table sessions) for routing to the TGB's. It also provides event logs, map locators, exception reporting and alarm notification.

3.Presentation Server: An optional Linux based computer that provides web interfaces for utility operations based upon data from the utility data base server.

Features:

- The Network Controller, NC, maintains a 60-day deep image of all raw data collected from the TGB's. This information is stored on dual redundant 160 GB hard drives.
- If the NC fails or loses communications with the TGB's then the TGB's will automatically store up to 30 days of metering data. The TGB's automatically downloads the saved data to the NC once communications are re-established.
- The Utility Information Platform, UIP, collects the raw meter data from the NC. The UIP un-compresses the information from each message and stores the most current data in its SQL data base. The UIP also uses that information to fill in any missing meter reads. The SQL data base is 60 days deep and is stored on dual redundant hard drives. In the unlikely case that data on both drives is lost, the UIP can rebuild 30 days of SQL data base by using the raw data stored in the NC.
- The RNI is accessible to AMDS systems software engineers via VPN which provides remote support. The 24x7x365 maintenance team of the tower provider and the responsible AMDS systems software engineer are both available for onsite service if needed.
- The RNI is protected by a surge protected 60 minute UPS.

How network operates:

A Commercial or Residential Meter **transmits to one or more cell-towers.**

The data is received by an Tower Gateway Base Station located at the base of the radio tower which in turn sends the information to an Regional Network Interface (while also storing the information).

The Regional Network Interface **is located on the Utility's premises, providing direct access to meter reads and a rich set of additional features. As a result AMDS never takes possession of customer or usage information.**

Economic Benefits of RF TGB:

Traditional wireless AMR systems rely on drive-by or [telephone] pole-top receivers. But this system utilizes **radio-towers**. One tower can replace over 400 pole-top collectors. Further, mountainous terrain can block the path of radio transmission. This is why an utility should erect multiple towers on the higher hills or mountain peaks

Chapter 7

Main Functions of AMR system

- Daily automatically scheduled collection of interval data from existing (currently deployed in the field) meters.

- Storage and management of all meter base data and meter reading data in central database.

- The data management system has the capacity to accept reporting on external factors from the billing system such as outage credits and curtailment intervals.

- The data Management systems shall have the capacity to calculate the billing factors including the following :

  - TOU Buckets.
  - Demand Charges.
  - Interruptible program baselines.
  - Other usage data calculated from interval data stream through an easy to use calculation engine without need for additional software development.

7.1 System Overview:-

The proposed system shall provide a suite of applications for AMR, Meter Data Management and processing and Analysis tools.

This platform will provide Utility company with the ability to centrally manage interval data collected by meter reading module, and to provide that data, and its derivatives to the specified offices using client server technology through the utility companies intranet.

Each of the local control centers should have an operator workstation to perform manual /scheduled meter reading, data management analysis.

All meter interval data has to be stored in the headquarter server and disk mirroring of the same is to be done at location specified.

7.2 System infrastructure Architecture:-

The system architecture shall utilize a standard multi-tier architecture, which will include following separate tiers:

I. A central database for storage and management of all meter-reading ns, load profile and meter configuration data.
II. An Application tier which provides processing power to accomplish standard operations including:
    i. Setup and maintenance of meter configuration.
    ii. Scheduling of Automatic meter readings and data transfer.
    iii. Editing and estimation of meter data
    iv. Ad- hoc meter readings.

7.3 Key Technologies and features: -

The system shall be based around the following key technologies which will ensure a consistent operating platform, which is scaleable for future growth and integration of new technologies.

7.3.1 Database Tier:

The database tier shall utilize the Microsoft SQL Server RDBMS, Latest version.

7.3.2 Application Tier:

The Microsoft.Net framework shall manage the delivery of application content. All applications related to the operation of the system shall utilize the Microsoft.NET framework for interoperability.

7.3.3 Rich-Client Tier:

Day-to-Day system operations and the activities of the system operators shall be performed using a rich client developed using the Microsoft.NET framework.
All applications related to the operation of the system shall utilize the Microsoft.NET framework for interoperability. The rich client shall be able to be

updated automatically and installed using the Microsoft Internet Explorer web browser.

7.3.4 Optional Web Tier:-

Any web applications which interface the system, shall utilize the.NET framework and Microsoft Internet Information server latest version.

7.3.5 Security:-

The system shall provide an integrated security system that allows administrators to create users and grant those users permissions to see/use the required data. User permissions shall be set at the functional levels based on the requirements. The system shall disable a username-password combination after a number of failed login attempts and report it to the administrator.

The number of login attempts shall be settable by administrators as a system Setting.

7.3.6 Groups:-

The system shall allow administrators to create groups of users with the same permission set. All users assigned to given group shall have the same permission at the system level.

7.3.7 Security Interface:-

Advanced users shall be permitted to grant and alter user and Group permissions through the GUI client. Users who are not administrators shall not be given any menu option for security or other administrative functions.

7.3.8 Automated Processing:-

To support production scale operation, the system shall automatically mange its load and processing tasks with minimal operator intervention. The system shall provide tools for automated scheduling and load balancing.

7.3.9 Automated Scheduling:-

Scheduling of routine tasks such as data collection and export to the billing system shall be handled automatically through the use of cycles. Cycles shall be user-defined schedules to which meters and tasks can be assigned. When a cycle Time or date is reached, any tasks associated with that schedule shall be scheduled for all meters assigned to that schedule. Automated scheduling by the cycle should be accomplished without user intervention.

7.3.10 Workflow:-

The system shall provide automated execution of common workflow processes in meter reading, specifically the read, validate, estimate, transfer process that is at the core of meter reading. This workflow process should be accomplished as automatically as possible, stopping only where human intelligence is required for tasks such as data editing or estimation.

7.3.11 Task Management:-

The system shall provide a centralized management system for all tasks, automated or Ad-hoc performed by systems backroom processing servers. This task management system shall schedule and manage the balancing of task load across multiple processing servers.

7.3.12 Ad-Hoc task Scheduling:-

The task management system shall provide properly authorized users to schedule tasks to be processed by backroom processing or dialing servers. Users shall be able to select all the parameters associated with the tasks, and to select the time and date at which the task shall be run, and to request that the task be run on a particular processing server.

7.3.13 Task Monitor:-

The task management system shall provide a graphical user interface for the monitoring, reporting on tasks. The task monitor shall aloe the user to perform the functions through an intuitive Graphical user interface.

7.3.14 Auditing: -

The system shall provide audit trail of user and system activities that enables data changes to be tracked and reported including the changes made by the system administrator.

For editing of meter reading and load profile data the system shall record the information in a log and store it for minimum of 12 months.

Interval Polling

In Interval Polling, the host computer initiates a communication transaction by making a request for current or real-time data from a meter periodically based on a pre-established interval. This interval is generally defined for each meter in an application. The polling rate for a particular device may be faster or slower than others depending on the criticality of the asset or application to which the meter is applied.

Demand Polling

In Demand Polling the communication transaction, the request for current or real-time data, is initiated from the host computer on an event such as a user input. As with Interval Polling the host computer initiates a request for data message that is sent to the meter. The main difference is that a Demand Poll is not scheduled and can happen at any time.

As with Interval Polls, Demand Polls can also initiate requests for natural gas metering data that is archived in RTU, EFM and Corrector field devices for audit purposes.

7.3.15 Maintenance:-

The system needs to be designed for easy maintenance, including utilities and GUI interface modules.

7.3.16 Performance size and Scaleability:-

- The system shall be designed to accommodate the CI meter data management needs of utility as it grows in the future.
- The following are the expected response times for specific types of processing.
- The system shall read, validate upload and export 2 million intervals/hr.
- The system shall export 5 million intervals /hr.
- The system shall aggregate and transfer 0.5 millions intervals /hr.
- The system shall respond to a data view query in the user interface of one
- channel consisting of 3000 intervals of time series data in less than 60 secs.
- The system shall allow channels of load profile data to configured with sampling rates (interval lengths) as short as 1 minute.

7.3.17 Data Management:-

The primary function of the system being contracted by the utility service provider is the collection, management, and exploitation of load profile data. As such the data storage and management of the system is a key function. The database shall support the storage of metering data and shall enable utility service provider to easily associate metering data with meters, customers, and service points within the network.

8.3.18 Data collection tasks:-

To support production scale operation , the system shall automatically manage its load and processing tasks with minimum operators intervention. Therefore the system shall support scheduled or pre-specified meter reading. The sytem shall allow operator to define at least 100 different reading cycles. And associate each individual meter to a reading cycle at any frequency down to 5 minutes.

It shall be possible for each meter to associate at least 4 reading cycles.

8.3.19 Ad-hoc meter reading:-

Utility operator shall be able to use the GUI Interface to initiate request to read a meter immediately.

8.3.20 Billing system interface:-

The system shall provide an interface to the Utility service Provider billing system using the native file format of the existing utility billing system. Export shall be processed automatically on cycle basis using the automated scheduling engine. Data exported will include meter data and other billing factors calculated using the TOU module.

8.3.21 Open API's(Application Program Interface):-

The system shall provide API's for meter data and configuration data that enable utility or third party to integrate the system with CIS, CRM, Asset Management or third party analysis system.

API's shall be based on **Open Standard**.

The API shall allow for both programmatic and file based access. For Programmatic access, the communication mechanism shall be web services .For file based access the system shall provide a file Scanner where by formatted files are loaded to a predefined directory automatically imported.

API's shall be integrated with the security infrastructure of the system, and require a username and password to operate. Access to functions using the API shall be granted and controlled in the same way as access is granted and controlled through the user interface.

When a utility models the benefits and economic impact of AMR/RTM it should consider the following:

- Ability to pass on system equipment acquisition costs to consumer in a win-win fashion.
- Ability to provide the consumer with real time information on pricing, consumption and billing.
- Ability to implement future variable tariff programs such as time of use, peak demand and real time pricing without having to change out meters and equipment in the field.
- Ability to be real time pricing and deregulation ready without future changes in hardware.
- Ability to transition from one communications media and network to another in the future without changing the meter.
- Reduction of costs associated with meter reading.
- Reduction of costs associated with account turn on and turn off through automation.
- Reduction of costs associated with service outage reporting and automated service dispatch.
- Reduction of lost revenue due to old and progressively less accurate meters being replaced by highly accurate new meters.
- Reduction of peak demand costs associated with power acquisition at peak demand periods.
- Aggregation with other utilities to reduce equipment and infrastructure costs by sharing with multiple users.
- Improvement in environmental impact through the reduction of pollution resulting from the lower peak gas demands and elimination of meter reading vehicle fleets.

Chapter 8

Economic Benefits

The economic benefits gained by the utility through the reduction of operating costs and the generation of new revenues through the provision of new services. With older AMR technology such as implanted modules in electro-mechanical meters and *walk by, drive by* receivers, the benefits are limited to a reduction in meter reading costs through man power reduction and reduced rereads. Newer AMR/RTM technology blends a whole host of cost reduction and revenue generation opportunities by combining many functions beyond just meter reading.

Examples include

- Real time service
- Outage reporting,
- Tamper and
- Theft of Gas
- Reporting,
- Introduction of variable rate tariffs (such as peak demand and time of use tariffs)
- Remote service connect/disconnect
- Improved cash flow from problem accounts,
- Reduction of the wholesale cost of Energy during peak demand conditions through a reduction of peak demand through voluntary demand side management by consumers empowered with real time pricing and usage information.

Significant attention needs to be paid to the communications or metering gateway at the subscriber's location to insure that the major system components can be shared by multiple utilities such as **electric, gas, and water.**

There are, however, a myriad of services and functions that can be accomplished through this communication system, some of which significantly reduce a utility's operating costs and some of which can actually generate additional revenues. The incremental costs associated with incorporating these functions in the AMR system controllers is marginal. Payback can vary enormously. In theory, it is almost possible to finance a full-scale AMR system installation through the resulting costs savings and new revenue-producing services.

- **Remote service connect and disconnect**-A recent survey indicated that the average annual turn-on and turn-off rate for gas utilities nationwide is 18 percent of total utility customers. Costs are incurred by sending a qualified service technician to a site to connect or disconnect a meter or power drop. With remote operation, these procedures are eliminated.
- **Energy management** - Indirect load control and direct load control offer a financially attractive alternative to increased production and delivery capacity.
- **Prepayment** - A number of utilities are investigating various prepayment systems. Such systems effectively eliminate collection problems and enhance cash flow.
- **Combining utility services** - By combining electric, gas and water AMR data on one system, the most expensive components, the communications infrastructure and the multitude of controllers, are shared by the utilities. Hence, the cost to each utility to go AMR system wide is reduced to less than 40 percent of what it would otherwise be.
- **Sub metering** - Multi-tenant properties can provide individual user data to the utility on a remote basis. The reduction of associated costs coupled with the magnitude of the transmitted information can, in many cases, allow the utility to offer its commercial customers new report-oriented services.
- **Customer display** - Utilities can enhance customer relations by selling internal display units to customers that provide up-to-the-minute monitoring of power consumption, in Rupees and paise. This can be used as an energy management tool and allows customers to verify and reconcile bills.

8.1 Remote Connect/Disconnect :-

The remote connect/disconnect device is a single-phase 200-amp switch mounted in a socket meter base extension. The device is installed between the meter and the customer's meter base; it is totally separate and independent from the AMR-enhanced meter. When the device is signaled from TNS to open, the self-contained breaker opens. When the device is signaled to close, it is armed to close. There is a switch on the outside of the device that the customer must operate to restore power. The arming switch is a safety feature to prevent remotely restoring gas supply without local acknowledgement. Because of the remote connect/disconnect device is rated for single-phase 200-amp services; it is not applicable to a large portion of our commercial and industrial service points.

Given this, the device would be most applicable to residential service points, particularly those residential service points with higher than average per visit costs and/or sites requiring frequent actual disconnects or connects. There are two activities on residential service points that could have some application for automated remote connect/disconnect switches. They are "customer-requested" actual disconnect or connect, and "credit and collection" actual disconnect or connect.

1. This facility is useful when the customer has not paid the bill before the specified date.
2. Some tampering is done on the part of the customer at the meter.
3. Meter Malfunctioning.

In conclusion, the practical application of automated connect/disconnect technology using remote switch units would be so limited that it would not provide any significant cost or process benefit for the following reasons:

<u>Disadvantages:</u>

1. Automated remote connect/disconnect devices are expensive compared to the cost of manual site visits.
2. An automated disconnect could lead to customer dissatisfaction.
3. Application of automated connect/disconnect devices on credit and Collection problem accounts raises more issues than it would resolve:
   a. No personnel contact or notification of disconnects.
   b. No opportunity for the customer to pay or make arrangements at the time of Disconnects.
   c. Communications other than in person are difficult with customers who have cleared accounts.

8.2 Theft Detection:-

The AMR system does not actually detect energy theft; rather, it provides information to help facilitate investigations of suspected energy theft. The Company's analysis of the applicability and benefit of theft detection/revenue loss is based on information recorded by the AMR system.

AMR has three methods to assist in identifying suspected energy theft and revenue loss:

1. Blink Count.
2. 24-Hour No Pulse.
3. Reverse Rotation.

1. Blink Count:

It is the number of events in which the meter module recorded an outage or momentary drop in gas supply at a customer's location. Possible causes for a Blink Count can include abrupt load application, gas supply failure, or removing the meter. When the Blink Count is recorded, it doesn't register what caused the blink or how long it lasted; it is simply a cumulative count. As a general rule, it is very difficult to correlate Blink Count to energy theft. It should be noted that a Blink Count may not be recognizable to the customer in service reliability.

2. 24-Hour No Pulse:

This occurs when there is no consumption in a 24-hour period. Possible causes include occasional-use applications, such as room heater, or situations in which a meter is removed and jumpers placed behind it. When the 24-Hour No Pulse is recorded, it isn't readily apparent if that is historically normal for the location or if there is something wrong. In order to reduce this number to something that is manageable, it would be necessary to make some modifications to how these meters are grouped and identified by the AMR system. By using the Device Location field to identify different groups of meters, it would be possible to reduce the list of meters that required research to a more manageable amount. For instance, if all meters that were turned off at the meter or source were assigned a

Device Location of OFF, they could be grouped together in the 24-Hour No Pulse query and not be reviewed.

3. **Reverse Rotation:**

This means the gas is running backwards through the meter. A possible cause of this could be if the meter was turned upside down. Very few reverse rotation situations have been recorded thus far. To determine if a problem exists, it is necessary to manually investigate each occurrence. The Customer Account Management Center (CAMC) can also identify many reverse rotations as part of the billing process. This action is possible when there are certain changes in settings of operation or by the customer to reduce the readings.

Conclusions regarding the energy theft capabilities are as follows:

1. The large number of Blink Counts recorded are mostly the result of normal operations. When Blink Counts are recorded, there is no addition information provided such as cause, duration, etc.

2. The 24-Hour No Pulse counts are recorded anytime an active meter has gone 24 hours without any recordable usage. This includes many scenarios where this occurrence is acceptable. When a 24-Hour No Pulse is recorded, there is no indication as to what type of service it is and whether or not no pulse event is consistent with historical data. With additional changes, time and resources, it may be possible to customize the 24-Hour No Pulse into a more usable format.

3. Reverse Rotations are recorded when Gas is flowing backwards through a meter. It is possible for the CAMC to discover some reverse rotations through their normal billing errors. There are relatively few reverse rotations recorded.

8.3 Growth Expansion and Component Life Cycle:-

Emerging trends such as the movement towards in-home computer networks and residential gateways must be carefully analyzed, as these will have a significant impact on data communications carriers over the next few years. As more and more demand becomes apparent for these products, cheaper forms of high-speed real time data communications will become available which may be integrated into the utility's AMR/RTM system. Therefore great care must be taken to select components having the appropriate life cycle requirements and which are capable of forward migration as technology progresses. As an example, an electronic meter must have a life expectancy of a minimum of twenty years in order to be considered for mass deployment. The meter should also be capable of supporting virtually all communication carrier technologies without having to be replaced or taken apart to be modified in order to support a future transition from telephone to RF to cable by way of example.

A utility must think beyond meter reading. The system components necessary to support automatic meter reading may be used to support a variety of other functions as well. Thus, the electric meter must be capable of supporting not only today's meter reading requirements but tomorrow's data and information services between the utility service and the customer through the link thusly established.

Consumer:

The consumer must be empowered to make intelligent choices about the consumption of utility commodities such as electricity, gas and water.
Cost of service and usage information must be provided in real time in a form easily monitored and understood.
A car has a fuel gauge and a speedometer. A fuel pump at the fuel station has a dispensing meter at the point of delivery. Thus the car operator knows the price of fuel at the time of purchase and can make decisions on the use of his car based on his budget and ability.

A home must have a fuel meter and delivery price gauge as well. This takes the form of an in-home display and control panel monitoring electricity, gas and water use.

This translates into an energy management system that almost invariably results in savings through the more judicious use of energy and utility services.

Chapter 9

Advantages with respect to Conventional Billing Methods

Automatic Meter Reading (AMR) Cost benefit Analysis comparing the costs between current meter reading methods and a variety of automatic meter reading methods. The basic AMR functions that the study addressed included the following:

- Monthly gas meter reading.
- On-demand gas meter reading.
- Eliminate errors from human factor.
- Reduce operational cost.
- Interval energy and demand meter reading.
- Outage detection.
- Monitoring of voltage, harmonics, and other power quality characteristics.
- Tamper detection.
- Customer "connect" and "disconnect" (via meter reads).
- Customer disconnect (via hardware switch).
- Load control and emergency load shed.
- Time of use metering.
- Monthly and on-demand gas meter reading.
- Electric, gas, and water usage profiling – whole house and by appliance.
- Real-time pricing.
- Providing billing information to customers on-line or over the Internet.
- Messaging to customers on Real-time pricing.

Additional meter-related service capabilities, which are already technically feasible with Internet access, were also included. With password security to ensure privacy, customers could access their own accounts to:

- Review and analyze their historical energy usage and bills.
- Review their current billing information.
- Request deferred payments and other billing changes.
- Request connects and disconnects.
- Receive information on utility services.
- Provide electronic payment for energy and other services.

Environment :-

AMR/RTM helps to protect the environment. Pollution is reduced by the direct impact of the elimination of meter reading fleet vehicles as well as the reduction of peak demand generation that often requires smaller fossil fuel peaking plants to be put into operation.

Benefits influencing the business case for Automatic Meter Reading adoption

- Energy usage costs to be apportioned to location, equipment or sub-level accounts.
- Identification of power hungry equipment and in-efficient usage practises through comparisons of peaks and trends across sites and equipment.
- AMR provides a business case for capital investment to facilitate reduced losses and costs.
- AMR provides feedback on energy saving measures where equipment usage translates into lost and saved cash and facilitates continual improvements for seasonal variations.
- Energy usage data provides a foundation for negotiation with energy suppliers to influence cost reductions at improved tariff rates.
- Automatic Meter Reading enables a pay-per-use business model, where predicted monthly cost savings pay for equipment lease or sell costs.
- Trending of energy usage enables optimising of energy generation and buying profiles through a AMR telemetry.

Chapter 10

Implemetation of AMR in Adani Energy(Gujarat) Limited

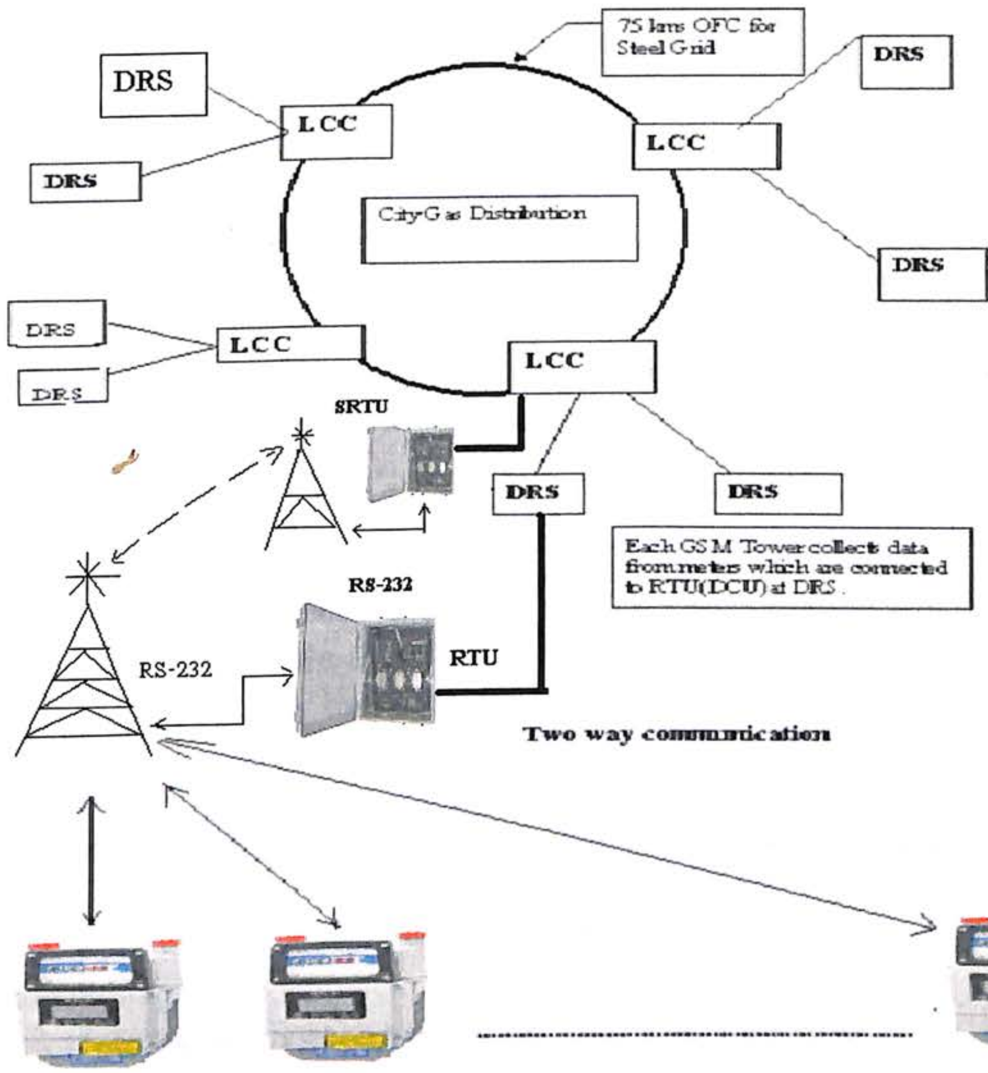


Fig.21 Concept of AMR to be implemented in Adani Energy

The primary function of metering system is to meter gas entering and exiting the operator's pipeline system for fiscal and operational purposes .Gas Metering has become very important for transportation and distribution companies because of increase in cost of Energy, Customization of Industry ,fair dealing between buyer and seller.

Selecting a metering system involves taking into consideration various factors: -

1. **Technical**: -Type of gas, flow, Pressure, permissible pressure drop, Load variation, Accuracy, Dependability and Expandability.

2. **Practical**: - Available space, operating personnel, type of sales contract.

3. **Legal**: - Metering of fiscal transactions or internal consumption monitoring standards to comply with (such as AGA standards)

Implementation of AMR in Adani Energy is mainly meant for metering gas for Commercial and Industrial Customers who are the bulk consumers. The steel grid circle of 75 KMs around Ahmedabad is equipped with 12 fiber optical fiber network which acts as a backbone for communication, along with other communication mediums.
GSM towers at different locations collects data from Meter's around 3-5 miles located near by. These GSM towers are erected at District Regulating Stations where Remote Terminal Unit is installed.

This RTU is connected to Tower via RS-232 for serial communication which acts as a data concentrator. such 3-4 tower at DRS communicates with the tower at Local Control centre where SRTU(Sub master RTU is located)
This SRTU collects the data and the data from other towers to which it is configured.

The RTU at Local Control Centre in turn communicates with the Master Terminal Unit at City Gate Station.

Gas Balancing:
At DRS metering is done so how much flow is going further in PE network is known. The number of meters connected to this DRS gives the exact consumption of gas. so if 300 meters(M_1,M_2,M_3...) are connected to this DRS_1, adding the consumption of all the meters should be equal to the flow metered at DRS in Real time along with some permissible losses.

$$DRS_1 = \Sigma M_1, M_2, M_3......M_{300} + 1.5 - 2\ \%\ \text{Permissible loss}$$

Similarly,
No. of DRS flow consumption should match the flow consumption at LCC

$$LCC_1 = \Sigma DRS_1+DRS_2+DRS_3......DRS_{24} + 1\%\ \text{Permissible loss}$$

Similarly,

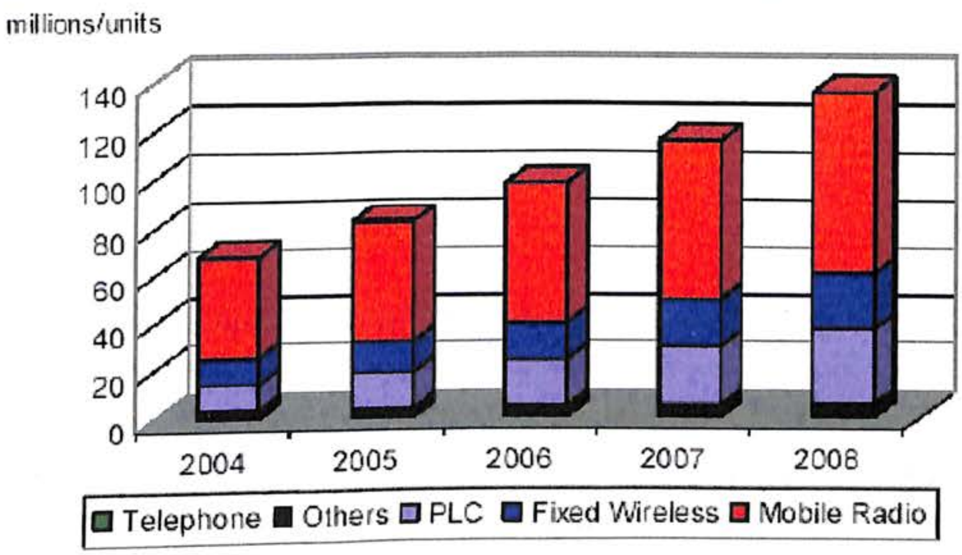
No. of LCC Flow should match the flow at City Gate station **(G)** from where gas tapping is done

$$G = \sum LCC_1 + LCC_2 + LCC_3 + LCC_4 + 0.5\%\ \text{Permissible loss}$$

By Gas balancing we can exactly know how much gas is coming in and how much gas is being consumed and how much are the losses. By gas balancing we keep the track of losses that should not extend beyond certain specified limit.

AMR Implementation in world:

US AMR Meters Deployed, By Technology 2004-2008



Source: On World Report: Wireless AMR & Submetering: A Market Dynamics Study on Fixed Wireless Technologies

In India also AMR is gaining wide importance for Electric and Gas metering due numerous reasons:

1. Increase in debt of State Electricity Boards and utility providers.
2. Monitoring Energy Consumption is getting momentum

In India leading Electricity suppliers such as Reliance Energy Ltd (REL), North Delhi Power Ltd (NDPL) and other state electricity boards are going for AMR through APDRP Accelerated Power Devpt. and Reforms.

Conclusion

- The deployment of an AMR/RTM system by a utility offers great advantages and opportunities to the consumer, utility, environment, and regulatory authorities alike.

- Cash strapped utilities looking for new ways to increase revenues and reduce operating costs should pay especially close attention to the opportunities afforded by AMR/RTM.

- The needs of the consumer should be put at the top of the list when considering system topology and component selection.

The Future:

Cost Factor:

AMR systems that are capable of using a municipal Wi-Fi network can avoid the installation and/or operational expense of another backhaul network for the AMR data. In the future, Wi-Fi enabled MIUs(Meter Interface Units) could use a municipal Wi-Fi network to allow each meter to communicate directly to the utility's central data processing center, avoiding the entire cost of establishing a telecommunications system dedicated only to AMR. Even more promising, if each meter MIU were Wi-Fi compatible, the utility might be able to purchase AMR equipment from a variety of different meter/MIU manufacturers, encouraging additional competition in the supply chain of both the meter and the AMR system.

AMR and municipal Wi-Fi offer potential synergies that may change the financial evaluation of both technologies.

References

1. Uttaranchal Power Corporation Limited, Dehradun

   (Project Report – Electric Metering).

2. Gujarat Adani Energy Limited.

3. Actaris Metering Systems.

   Technical Support.

4. Sensus Metering Systems.

5. Advanced Measurement and Design Systems.

6. Flowserve(Manufacturer of Valves and Measurement System).

7. Bristol Babcock.

8. USCL Corporation.

9. Automation Solutions.

10. Gloabtel Convergence Solutions.

11. Automatic Meter Reading Association (AMRA).

12. Automatic Meter Reading by Tom Tamarkin.

13. By Ram Labs.

14. Emerson Process.

15. Idaho Power Corporation AMR Project Report.