Chapter 2

Analysis of Existing Systems

In order to improve irrigation efficiency in general and to assure a reliable water supply to users in particular, many water resource / distribution projects in India, Irrigation departments of various states have taken up the challenge by remote monitoring and controlling of various physical structures and parameters. In most of the projects, it has been planned for a small segment of the existing canal system as a pilot project for study; analyze the benefits of improved water management systems, which can be implemented at more and more projects to cover a larger area later on.

There are some systems installed in India, either for total control and partial control or monitoring of the canal.

Researcher visited the following sites for analyses are:

1. Mazalgaon Canal control
2. Khadkwasala canal control
3. Rajghat Canal system
4. Venuguntha canal system
5. Tungabhadra canal control
6. Indira Gandhi Nahar Pariyojana, Jaiselmer, Rajasthan.

The details of few projects are given here

2.1 Pilot Project for Dynamic Regulation at Mazalgaon:

This project at Mazalgaon Right Bank Canal (MRBC) was one of its own kinds, using Dynamic Regulation of Dynamic Regulation of canal, which is a new technique adapted now, in most of the developed countries, where in water is made available to the user any time during rotation, so as to mitigate various local irrigation problems, like type of crop, labor, equipment, social structure, and most importantly natural problems.

The system was designed, installed & commissioned by GERSAR from France. The project started in the year 1996, took two years for Installation & Commissioning. The canal was running for one or two rotations with some problems (1998-2000). The system is not use since year 2000.

Researcher studied the project with following observations:

2.1.1 Master Control Center (MCC) (Parli-Vaijnath)

The Central Control Station is installed at this location. This is an ideal place at central location for control of about 100 Km. canal. Communication of both for voice and data from this location to all the monitoring / controlling locations is quite good, as it has to cover not more than 50-60 Km line of site at any location.

Systems installed at this site are:

- Fully furnished control Room, with office for attendant and service staff, which is still in very good condition, and can be put to use anytime.
- Master Computer Digital VAX Computer system - It is having open VMS operating system. All the required Control & Monitoring software was installed on this machine. The source code of the software was also not available, for study. Dynamic Regulation of canal is quite a modern concept. It was not possible to start the system. It is very difficult to get any spares as well.
- PROCET Computer- This computer is a standard IBM PC, with Windows operating system with inbuilt Add - On WIRELESS MODEM CARD. After discussing with the present staff and the document, revels that this system had some problems initially, but was working fine for two rotations. The problem was probably due to heavy lightning at that time. This computer is used to communicate with all the Field Stations, via Motorola Radio Sets, operating in VHF frequency range.
- Printers – Two Dot Matrix printers, one routine and other abnormal event printings are provided.
- Voice Wireless Sets – Apart for data radios, there is a separate voice radio link, at all the locations. Voice Communication Network is separate than the Data

Network. The staff on the duty is using the network for voice communication from Cross Regulator to Cross Regulator.

- Air Conditioners – There are quite a few Air Conditioners with Voltage stabilizers, operating on 415 Volts three phase power supply. Three Phase AC units might have been used to have better distribution of Electricity.
- Control Panel – This panel is used to switch ON/OFF various units and is still in use. One Regulated DC Power supply cum Battery Charger is also provided, for operation of Voice Sets during power failure. All the meters were in operating conditions.
- 15 KVA Three Phase UPS- 15 KVA Three Phase UPS with Isolating transformer is also installed sufficient to run the total system for 2 hours, as per the information, is not in operating condition.
- 30 KVA Diesel Generating Set with AMF Panel – One 30 KVA generating set with Auto Mains Failure (AMF) panel is installed at site. If the power fails for long time, than this generator set will deliver power.
- Sixty Meter Mast – A huge 60 meter Mast required for communication is in good condition. This mast was essential to have communication with all the Cross Regulators and a Head Regulator.

2.1.2 Head Regulator at Mazalgaon Dam

There are Three Vertical Gates of 3.9x2.4 Meters for canal, with Three Gates for Hydro-Electric Generating sets. Three Hydro Electric Generating sets, each of 250 KW are installed. Water is diverted through these gates generating electricity during operation. Two Generators were working at present. The required discharge is adjusted by opening the gates.

There is a control cabin divided in two parts, which is in quite good condition at the Head Regulator. All the equipment is installed in one room.

Equipment installed in the one part of Cabin is:

- RTU Panel: This panel contained RTU, S100 from Alkatel, France. The Keyboard Display, i.e. Man Machine Interface (MMI) was also present at front panel, to display the required parameters, and programming the RTU. Wireless Modem for

Radio communication, is present in this RTU. PLC is installed in the panel, for controlling the gates. The RTU panel was not working.

- Electrical Control Panel: It works in both AUTO / MANUAL mode. The panel is in operative condition except Gate Measurement System. Gates are operated as per the requirements with the panel in MANUAL MODE. All the required switchgear to operate motors of the Canal Gates is a part of this panel.
- Batteries: Generally the system works on 24 Volts DC. Another 12 Volt Battery with charger was present for Voice communication Wireless Radio.
- Wireless Sets: Two wireless sets are provided. Voice communication is still being used. The wireless set used for data communication may be kept in stores.
- Standing Wave Flume (SWF): There is one SWF at about 100 meter downstream of Head Regulator. This SWF is used to measure the canal flow. Two Stilling Wells, one at Upstream and other at Downstream are provided. Ultrasonic Level Sensors were installed, in each stilling well to measure water level in the canal. The sensors are still installed. The cabling also seems to be fine.
- Forty Meter Mast: Similar to MCC, 40 meter mast is still in really good condition. Both the Antennas are installed properly. The voice communication is used for day today operation during Rotation.
- 130 KVA Generating Set: There is one 130 KVA Diesel generating set is present at Spillway gates, to operate the gates. This generator is also use for operating the Head Regulator gates. The generator is used only during gate operation.

2.1.3 Ganga Masla Branch Canal (GMBC)

This is a branch canal to main canal. The control system was tested at this branch canal.

Canal is located just upstream of 1st Cross Regulator. There is a control structure at the beginning of this section. There are three hand operated vertical gates to control the flow. There are few constant discharges AVIO Gates. Some additional constant discharge AVIO gates are installed at the inlet of Command of Water Users Association (WUA). Water is supplied to these WUAs on volume basis. AVIO gates deliver water at constant discharge irrespective of upstream water level. The operation of the gate is adjusted by mechanically in order to have constant discharge.

All of these gates are in operation, since installation in 1998. After discussing with the staff, it was learnt that initially farmers were reluctant to use these gates, and tried to tamper them. But lately it was learnt that others are asking to install these gates on their distributaries, as they get constant discharge at all time in spite of water level, and farmers can plan their water management in a much better way. Installation is quite good, and is not corroded even after 8-9 years of almost continuous use.

Duck bill wear is constructed to have constant level in the canal, to have constant discharge.

2.1.4 First Field Station:

First field station (Cross Regulator 1) is located around 10 Km away from Head Regulators, This field station is about one Km downstream of Ganga Masla Branch Canal (GMBC). There are three motorized Radial Gates on main canal and are in working condition and Two Vertical Escape Gates. Sensors for Gate Measurement system were installed but were damaged. Regular mechanical maintenance, painting was going on during visit.

Two ESCAPE GATES to be used under emergency to release water to nearby nalla are rarely used. These gates are either fully open or fully closed. The sensing is done either for Fully OPEN or Fully CLOSED position only, with proximity switches.

The two compartment control cabin was intact. The compound was also neat and clean. The watchman was also present in spite of remote location. The 10 meter tower for antenna was fine and was neat & clean with very good foundation. Both the antennas were present. The antenna for voice communication is being regularly for passing the required messages.

The front room had following:
Panel Contains Alkatel S-100 RTU, with Human Machine Interface (HUM), PLC and other units:

- Electrical Control Panel containing all Switchgear, Logic, Gate Measurement system, Alarm Annunciator, Switches for various operations, including Auto, Manual etc. are available. All the switch gear and control logic is fully

functional in MANUAL mode of operation, and is regularly used to operate the cross regulator gates.

- Provision for Two Radio sets was there, but only voice radio set was present, and is being used regularly.
- Twelve Volt batteries were present, and are utilized for Voice Radio set for communication.
- Ultrasonic level sensors with Transmitting Units were present at both the upstream & downstream well covered stilling wells.

2.1.5 Third Field Station

This field station is almost similar to 1st Field station. The structure is almost same. The only difference is the tower height. A small 7 Meter tower is used in this case, as this cross regulator is quite near to MCC at Parli, and not much obstacles are present. All other details are like the 1st Field Station.

2.1.6 Staff

One of the major reasons in non-operation of the system is Technical staff. The staff which was trained during installation, commissioning, trials was not there at this site, due to Transfer, Promotion, Retirement, Voluntary Retirement, etc. and the new staff even interested could not get knowledge about the system. The researcher could not locate even a single staff present during working of the system.

2.2 Khadkwasala Canal Automation system:

This is a very prestigious canal supplying drinking water to historical Pune city, and irrigation downstream Pune. This is a valley project. There are three dams namely Panshet, Varasgaon, & Temghar upstream of very old Khadkwasala dam. The project was very crucial, as it was dealing with drinking water problems of Pune city and Agriculture water to nearby villages including Baramati.

2.2.1 Khadkwasala Dam Site

- Control Room with Control Console. The control console is being used to operate the Head Regulator gates, in Manual Mode. It is in working condition. Remote Terminal Unit (RTU) was in place, but not aware if it is working, as it was not

possible to check or being used anytime, and is idle. It is not accepting any Signals from sensors, and indicating anything. It was learnt from the authorities that it worked for some time, but it did not work continuously for long time. The Gate control is being done in LOCAL mode.

- Gate Control Actuators: Gate controllers were installed to operate the Head Regulator gates, both in AUTO / MANUAL mode. Most of the time the gates are operated in MANUAL MODE only. But all the actuators are working fine. These are electrically operated very expensive actuators. The gates at most of the HR locations are being operated by Hoist.
- The Level sensor is installed, near the Spill Way gates, which is far off, may be more than 1000-1500 meters from the Head Regulators. The Level signal of 4-20 mA is carried through a cable, which is broken at different places, as it is not being maintained for a long time. Thus the Level also cannot be seen at the RTU end.
- It was learnt that there was a complete Hydrometric station at this site. There are only few instruments available at this location, but no data collection or data storage is possible, as no sensor is connected to the RTU, and in operation.
- It was learnt, that the wireless system was installed, and commissioned, but the data communications was not proper, due to frequency allocation problems. Two allocated frequencies are so near to each other, that the cross talk created the problems in reliable data communication. The problem was not sorted out. The voice communication system is working at some other frequency. This problem was assigned to Wireless Planning Commission (WPC), but no concrete solution could be resolved.

2.2.2 Master Control Center (MCC) at Sinchan Bhavan, Pune

After discussing with the authorities, it was found that, as the system was not in-working condition for quite long time, and they were in short of the work place for their normal operation, all the components for the system was removed from this place, and the computers are being used for normal office operations.

2.2.3 AGROMET Station at Yawat

- It was learnt that most of the sensors were installed, and there was a report that most of them were in working condition, for some time after installation and

commissioning. However some of the sensors did not work at all, or could not be tested.

- Radio set was ON, but nothing could be done, as the Repeater station at Bhuleswar was not in operating condition. The repeater did work for some time, but went out of order, it was sent for repairs, and was not installed, since then.
- RTU was in working condition, with LCD display ON, but no parameter could be displayed, as no sensor was in operating condition.
- Batteries, which are generally most vulnerable, were found to be in very good condition.
- Communication Mast with GP antenna was in good condition though it was covered with trees. This antenna is regularly being used for normal voice communication.
- The building was in good working condition and maintained properly.

2.2.4 Cross Regulator at KM 72

- As rotation is already complete, and the rains were expected, there was no water in the canal. It was almost dry. There was a distributary at this point. Some wall was created with gate at the center to have sufficient head for the discharge in the distributary. The canal was broken at many places, and was being told that it will be repaired before next rotation.
- Gates are manual and are in operative condition.
- The flow measurement structure was in good condition, but the sensor is not installed.
- The building was in good conditions and maintained properly.
- Tower with GP Antenna, was also in good condition, which is used for voice communication.
- The overall system was not in use for long time, so nothing could be seen in working condition.
- Solar Panels were installed, The system was installed 10-12 years before and still existing, but could not see any operation

2.2.5 Motorized Control Gate system

- The gate was installed with Motorization.

- Big control room is there in good condition.
- A diesel generating set is installed, but could not be tested. It was known that the set was not used for long. This set was installed to operate the gate, during Power failure, in complete AUTO mode of operation. The RTU was kept in other room with lock and key.
- The Tower with Antenna was in quite food condition.

2.3 Rajghat Dam Canal System

The Scheme consists of Rajghat & Matatila dams. Dhukwan, Anguri & Bhutan barrages with total canal length of about 300 Km long.

The present system is as per following:

There is a Master Station at Datia, six SCADA Stations at Datia1 at Datia, with Eight Field Stations, Datia2 at Datia with Five Field Stations, Jhansi with Seven Field Stations, Chanderi with Five Field Stations, Lahar with Four Field Stations, Rajghat Dam with Six Field Stations, and Betwa River Board (BRB) Office at Rajghat Monitoring for River Group. There are two Repeaters at Dhukwan Weir, and Akhadeva, Field Station.

Field Station consists of two room type of Field Cabin, Suitable Solar Panels, Solar Power Supply with Battery Charger, Micro Controller based RTU with Data Communication System, Water Level Measurement Sensor in the Stilling Well, Flow Measurement Structure, Suitable Tower with Antenna for Voice and Data Communication, Voice Communication Set, Suitable Batteries.

Separate Voice Communication Units are provided at each Field and SCADA Stations. The network is suitable, such that each field station can talk to its parent SCADA Station.

The RTU collects and stores the required data through various sensors provided at each field stations, every 15 minutes. Generally all the sensors give 4 to 20 mA output signal, proportional to the actual parameter. The data storage is for one year and can be retrieved through the command. The REAL TIME CLOCK (RTC) is provided with each RTU. Battery Backed RAM (BB RAM) is used to store this data. The RTU

is same for the entire field Stations, but is programmed for particular site though local key pad and the 20x4 alphanumeric backlit LCD display, under Program mode. The same display is used to indicate the required parameters during run mode.

Alarm conditions for various parameters are programmed in this RTU. If any parameter overrides this value, during operation, alarm is generated, and is transmitted along with the present value. Apart from these operational alarms, some other alarms like Battery Low, PV (Solar) Fail, Electricity Fail, Sensor Not Responding, are also generated and transmitted to the master station, for appropriate action.

SCADA Station consists of Cabinet holding Industrial Grade Computer, with Software. UPS of Three Hours backup, RTU with Wireless Tran receivers, GPS System to Synchronize the Real Time Clock, Voice Communication Set, Dot Matrix Printer, suitable Tower with Directional Yagi Antenna for Data & Voice Communication, 12 Volt Batteries.

The SCADA Station collects Field Station data by poling method every 15 Minutes. SCADA Station broadcasts the request with particular identification code, confined with each Field Station affiliated to that particular SCADA station. All Field Stations receive this request, and identify itself, and sends the stored data to SCADA Station, with its identifying code. The SCADA Station stores this data, and displays the same on the Industrial Grade PC screen. The Global Positioning System (GPS) time Synchronizing is adopted for REAL TIME CLOCK of each SCADA Station. Similar to Field Station, some errors like Power Fail, RTU Not Responding are generated by the SCADA Station and Transmitted along with the Field Station data.

MASTER Station consists of Air Condition Cabin with Two Room Configuration, with storage place. Cabinet holding Industrial Grade Computer, with Software, to the needful, UPS of Six Hours backup, RTU with Wireless Tran receivers, GPS System to Synchronize the Real Time Clock, High End Computer Server, Laser and Dot Matrix Printers, Voice Communication Set, Suitable Tower with High Gain Omni directional Antenna, for Data & Voice Communication, and 12 Volt Batteries.

Similar to SCADA station, Master Station located at Datia also collects the data from all the SCADA stations one by one, by requesting the same. All the timings are

adjusted such that the data collection by all the SCADA stations and that of Master dose not clash each other. Time Synchronizing of all the SCADA and Master helps in synchronizing all the SCADA and Master clocks within 10 millisecond accuracy, every 12 Hours.

The basic Windows based Software residing on used with the Industrial PC, controlling the operation of this SCADA System, i.e., collecting the Field Station data through SCADA station, is not alterable by the user. All the collected data resides on the Server all the time.

The extensive software is used and all post data manipulation like Trends, Hydrograph, Total Discharge, Cumulative Discharge, Deviation from the Required Discharge for particular rotation or for the year, etc. can be viewed on the Monitor and print out can be taken if required. This type of data is really useful in Decision support System. The Soft copy also is possible. Any other software also can be seen at later stage, to view any useful parameter, if required.

The Master Station receives all the Alarms with the data transmission and appropriate action is taken. Once the any new alarm is received, one has to acknowledge the same, and the action is taken. The details of all the alarms with Time Stamp are stored in the tabular form for future analysis.

The total Canal Map of 4' X 3' fixed to the wall indicates the Flow and Levels of some of the important points. This map is placed such that you can see the same immediately when you enter the Control Room, giving the overall view at glance, at Datia Master Station.

Voice Communication:

The operation of the Canal can be or will be controlled by the use of Voice Communication network. Person on duty can be instructed like Opening or Closing of Gates at particular Cross Regulator, through Voice Communication, via particular SCADA Station, and then to Field Station. The effect of any change can be seen directly on the screen in the next 15 minutes. We can call for the immediate data, if required, under emergency. Vehicle mounted, and hand sets are also provided, to

communicate to near field station, in the case of emergency or at the time of maintenance.

It was learnt that the system was working till the warranty and maintenance period, and is operating in some way

2.4 Vinukonda Canal Automation Scheme

Vinukonda is in the state of Andhra Pradesh. This Project relates to the Canal Automation of a pilot area in Blocks 11A to 14 of Nagarjunsagar Right Canal System (NSRC).

The project is installed on distributary of Nagarjunsagar canal. The scheme controls about 30 Km canal, receiving water from 3 different Head Regulators from main Nagarjunsagar Canal.

The canal automation concept is installed for 19 gate sites with 30 gates that are automatically controlled to a flow or level set point (at main canal off-takes and at boundaries between Water User Associations), and flow measurement at a further 11 sites. The upstream control method is implemented at this site, as sufficient freeboard is available.

“Solar Powered Gate Actuators” was the specialty of this scheme. This method avoided the requirement of unpredictable power supply, at cross regulator creating problems in control application. If the gates cannot move even after receiving command from the Control Center due to power source, the complete system is of no use.

The use of Digital Radios both for data and alarm communication is another aspect of this scheme. A second radio is used alert the operator under typical alarm condition, for proper operation of the total system. A separate voice radios were also used for communication.

It is learnt that scheme worked for first few years of installation and maintenance.

2.5 Tungabhadra Canal Automation Scheme

The Tungabhadra project was conceived and executed to serve the chronically drought-prone districts of Raichur and Bellary of Karnataka, and Anantpur and Kurnool districts of Andhra Pradesh. Tungabhadra Board was constituted by the Government of India to manage this project tin 1955. From the 2 300 Mm**3** of water expected to be developed by the project on average over the long term, Karnataka receives 1515 Mm**3** and Andhra Pradesh 785 Mm^{3}.

The Tungabhadra project involves three main canal systems, viz. on the right side (both a low-level unlined and a high-level lined canal systems) and on left side (lined canal system), running for a total length of 750 km

This scheme was probably the first of its kind to be implemented in India, at RBC of Tungabhadra dam in Karnataka. It took quite long time to install, as it was totally a new concept.

Most of the equipment was imported, with almost no spares. It was very difficult to import any electronic equipment at that time.

It was learnt that some major imported components were not working during installation, and then it was not possible to import the same.

There is no status or working report available for researcher to study.

2.6 Indira Gandhi Nahar Pariyojana (IGNP)

Indira Gandhi Nahar Project (IGNP) is one of the most gigantic projects of the world. The project includes drought proofing, drinking water improvement, rehabilitation, development and protection of animal wealth and increasing agricultural produce.

Distribution of water among various stake holders of the project is controlled by three Chief Engineers located at Hanumangarh, Bikaner and Jaiselmer. Prior to the year 2010, the system was regulated manually observing water levels and gates openings. This manual observation system cropped conflicts between various zones, even highest officers did not know about the correct discharge in various canals. Government of Rajasthan, decided to install and implement telemetry SCADA

measurement system on IGNP to achieve efficient control, timely, reliable and equitable water delivery to the stake holders through modern technology pertaining to automatic operation and telemetry arrangements by measuring canal flow and gates automation.

Installation of SCADA system

SCADA system covers the entire IGNP scheme, with Hari-Ka-Barrage as the beginning and Jaiselmer at the tail end, covering about 660 Km of canal length shown in Fig.2.1.

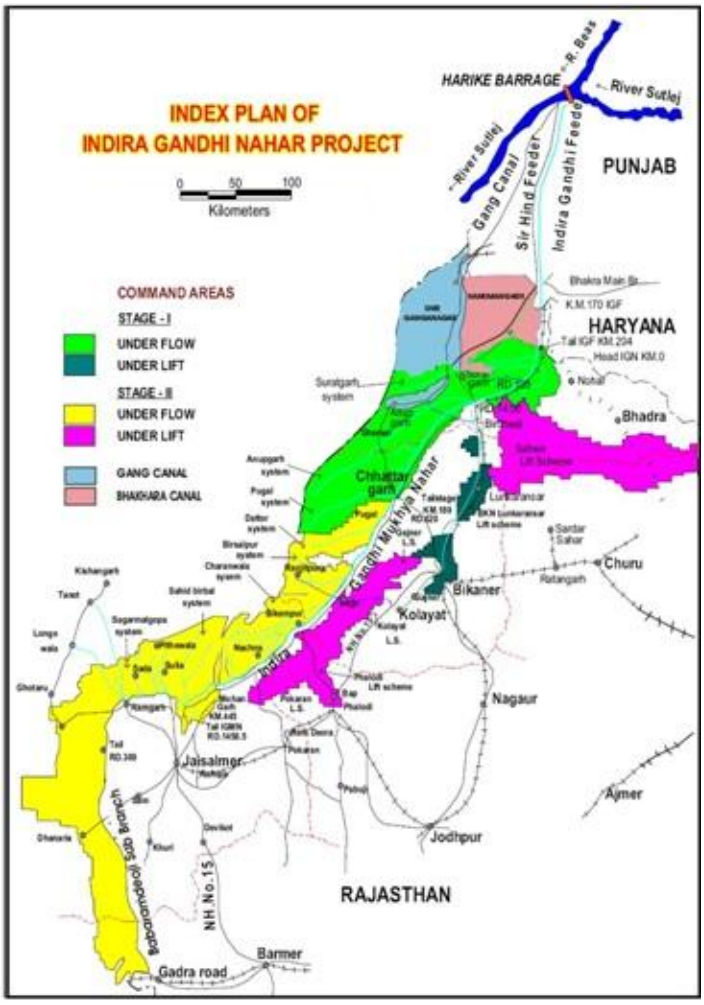

Fig.2.1

There are two Master Control Centers (MCC) at Jaipur and Bikaner, three Regional Control Centers, (RCC) at Jaisalmer, Bikaner and Hanumangarh, eleven Field Control Centers (FCC) at Ramgarh, Mohanbgarh, Nachana, Phalodi, Bikampur, Baiju,

Chhattisgarh, Lunkaransar, Shribijay Nagar, Suratgarh and Rawatsar, with fifty three Measuring Stations, including eight Lift Irrigation (LI) schemes at Shawa, Kawarsain, Gajner, Barsigsar, Bangarsar, Kolayat, Phalodi and Pokharan. Fig. 2.2 indicates the Scheme of SCADA for IGNP.

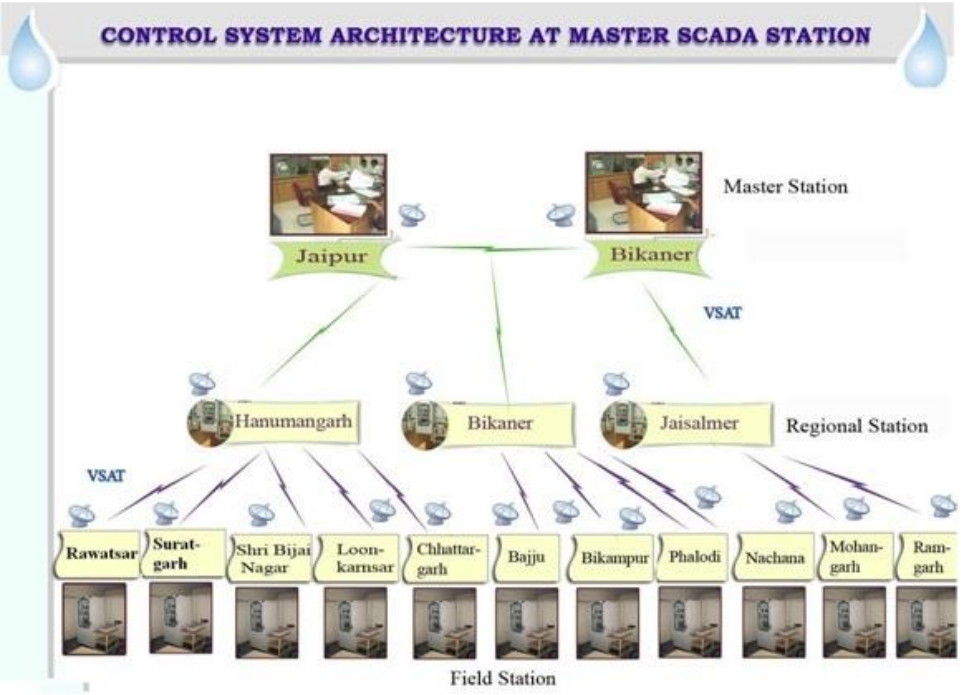

Fig. 2.2

Measuring Centre

On Line Acoustic Doppler Current Profiler (OADCP) - side looking one is used on all the canal branches measuring Discharge and Cumulative discharge. The same data is also stored in the unit, and can be uploaded to any PC or laptop. It has internal level measurement sensor as well. There is a facility to program normal shape canal dimensions. Proper mechanical arrangement provides for easy maintenance. However, it was programmed with the data actually received with Down Looking Acoustic Doppler Current Profiler (ADCP) River Surveyor which gives the actual shape and area of the canal during cross-sectional traverse of the same, improving the accuracy of measurements, as As-built dimensions may not be the same as design dimensions. Typical installation of the OLADCP is shown in Fig.2.3

Fig.2.3

Ultrasonic Level Sensor – These level sensors installed in the stilling well, measures the upstream level of the canal.

RTU (Data acquisition and Storage Unit) - This unit collects the data for all the sensors, including Gate position at control points, every minute, indicates the same on Alphanumeric LCD display. The Real Time Clock (RTC) synchronized to standard Global Positioning System every day, stores the data every 15 minutes. Thus data for one complete year is available. The data is then transmitted to MCC via VSAT every hour. The unit works on 12 Volt DC batteries.

VSAT Transmitter with Dish antenna – This unit is used to communicate the data collected by RTU to MCC. 1.2 meter dish antenna faces the satellite. This unit also accepts the commands from MCC to operate the gates at control locations. The unit communicates on both the directions of data flow.

Solar Panels, Batteries, Battery Charger – Since most the measuring centers do not have any utility (mains) power, the complete system is Solar Power based. The Solar Panels and Deep discharge batteries are designed to offer ten days to power autonomy.

Acoustic Doppler Current Profiler (ADCP)

River Surveyor is used to confirm the discharge and area measurements, by moving the ADCP in a boat across the canal width. A differential Global Positioning system provides better than 1 cm accuracy, and makes it immune to the lateral movement of the boat, once the start and end points are confirmed. Typical operation is shown in Fig.2.4

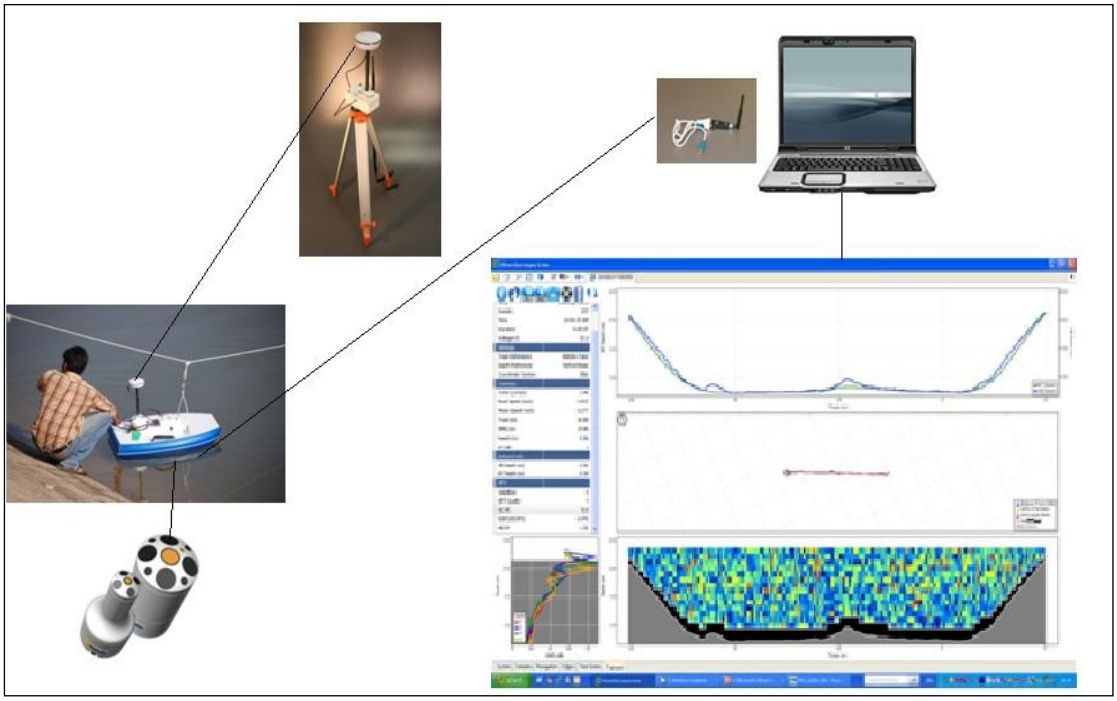

Fig.2.4

Control Centers

Mater Control centers (MCC), Regional Control Centers (RCC), Field control Centers (FCC), are similar, each equipped with an Industrial Grade computer with SCADA software installed on the same, and VSAT communication equipment with 1.2 meter dish antenna. Generally the corresponding SCADA is working at each particular machine at particular location. However the data of all the other Field Control Centers are available. This helps in dealing with proper decision support schemes. Appropriate Uninterrupted Power source with sufficient back up is provided at each center. The screenshot of the system is shown in Fig.2.5A & Fig.2.5B

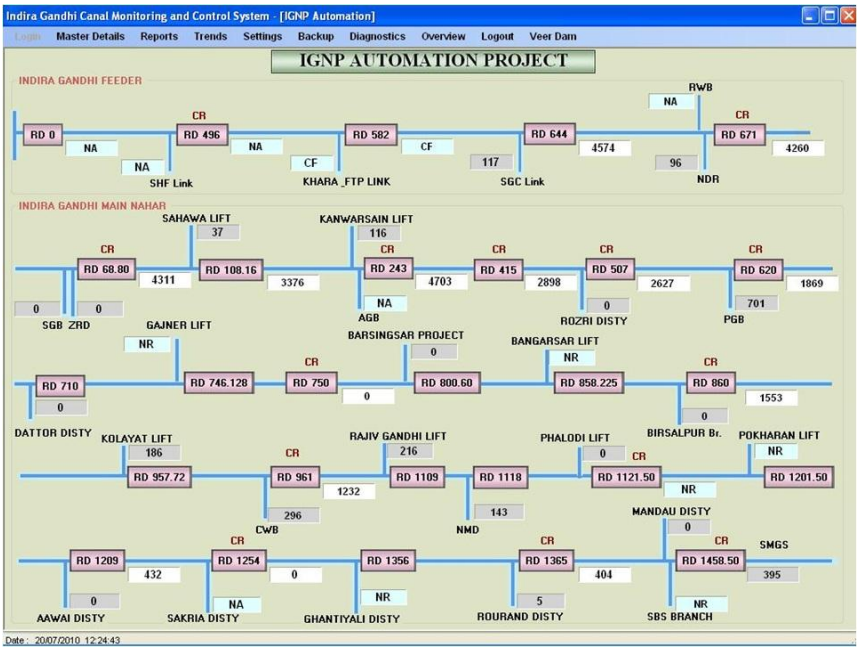

Fig.2.5A

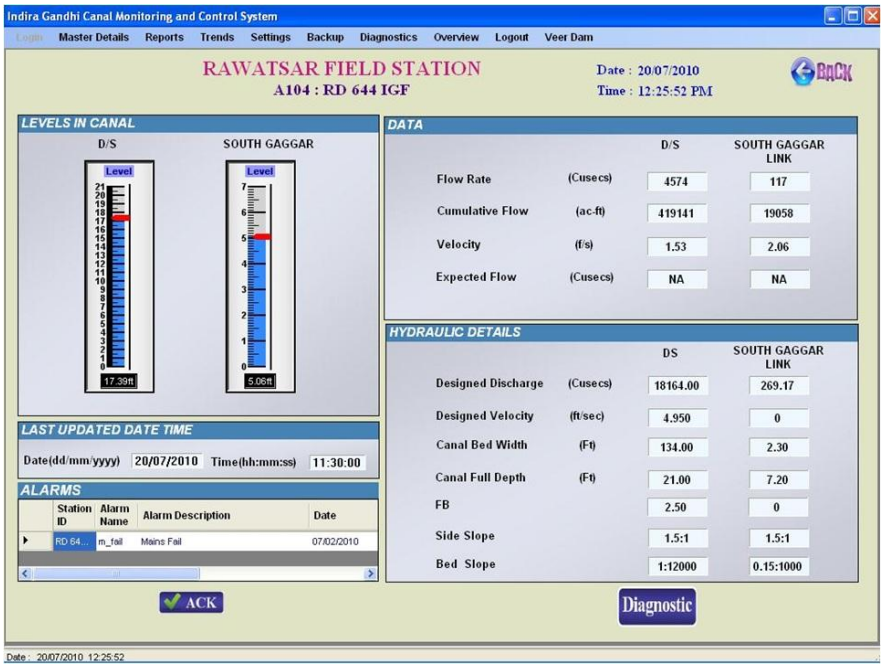

Fig.2.5 B

Deviation from Empirical Formulae

IGNP receives share of its water based on the availability of same in the river Ravi and Beas. In the year 2010 water available was very low, hence IGNP was running with almost 30-35% of its full capacity. Deviation of more than 10% was observed in measurements by SCADA system as compared to established empirical Formulae.

Critical analysis was carried out to confirm the accuracy of installed SCADA system. Main causes of deviation were:

- Adoption of constant value of coefficient of discharge Cd, irrespective of quantity of water flowing in the canal, but value of Cd, is much higher for higher discharge and is less for smaller discharges.
- Frequent operation of canal gates including main canal causes additional pooling and depletion of water in upstream mass volume causing disturbance in hydraulic equilibrium of channel flow.
- Designed profiles are used to calculate discharge in the canals and no consideration is given even if the canal silted and there is formulation of vegetation.
- As-built canal profile may not replicate the designed dimensions

Field studies were carried out revealing that manual recording in the registers is different as compared to site conditions. Correct existing profiles of canal were also observed at many locations.

Doppler SL1500 was tasted with velocity measurement device at Central water and Power Research Institute, (CWPRS) Pune, and it was established that discharge measured by Doppler SL 1500 matches with the measurement device.

Regression Analysis for measuring discharges form Doppler and calculated from Cross Regulators gate opening with constant value of 6.5 were also carried out.

Temporal distribution of discharge estimation both by ADCP and Doppler was carried out and were found in order.

Correction in constant value of Cd, during low discharge runs in canals, is essential and this was suggested to project authorities to adopt varying discharge of values of

Cd, in different varying discharge in the canal, while calculating discharge from empirical formulae.

The complete discharge data at the all measuring locations is measured with same type of instrument; not requiring calibration, along with upstream level measurement without any manual intervention is available at a time making it very easy for appropriate decision to schedule and reschedule for proper distribution of water for Irrigation and drinking. Since all the measuring locations are scanned every fifteen days, with ADCP, confirms siltation if any, during that time, and appropriate action of modifying the present area for discharge calculations is done, thus correcting the actual discharge values. With trend curve software, any extra leakages, in any particular reach are confirmed, for appropriate action, satisfying everybody.

******