DMA DESIGN & MODELLING OF URBAN WATER SUPPLY DISTRIBUTION NETWORK IN INDIA

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ABSTRACT

Drinking water is an essential basic need for all lives. Most of the Urban utilities in India supplying water to communities, and charge for the water supply through metered consumption or flat rate basis based on the value of customer properties. However not all the water produced in water treatment plant reaching to consumers and generate revenue for water utilities. A substantial amount of water does not yield the revenue to the utilities which is called Non – Revenue Water (NRW). It is the difference between volume of water entered in to the supply system and volume of revenue generated. The water losses are mainly due to leakages and unauthorized consumptions^{1,2}.

In order to understand the root cause and identify the major water loss prone area of the water supply scheme, the large water supply system will be divided in to small discrete areas, which is called DMA (District Metered Area). This chapter represents the approach of the DMA Design, which is the initial essential step for the formation of DMA along all the existing water supply schemes. This report has been prepared based on the on field experience in India^{3,4}.

KEYWORDS: Urban Water, DMA Design & Supply System

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INTRODUCTION

The concept of continuously monitoring the behavior vide sub zones or District Metered Area (DMA) in a water supply system is accepted and proven technology worldwide and well established technique for monitoring and identifying areas which contributing more of water losses in the water supply system.

The technique requires setting up of a discrete zone along the water distribution network. DMA must have the boundary with permanently closed boundary valves as boundary will have complete integrity without any pipeline breaches to out of the boundary.

The size of a DMA will vary, universally the DMA contains 1000 to 2500 Nos of house service connections. Ideally DMA will be formed with one inlet equipped with bulk meters but some cases two or more inflow points equipped with bulk meter based on the ground reality. The creation of DMA concept illustrated in figure: A

Continuously monitoring the DMA behavior allows the engineer to assess the leakage prone area which reduces the awareness time for new leaks. Hence DMA is considered to be the major contributor to cost-effective and leakage management. Also this DMA will lead the utility to derive the economic level of NRW which in terms save huge cost to utility as well as it will act as a decision making platform when and where to take action and

investing money to reduce the water losses efficiently^{5,6}.

In this report we have explained the criteria of DMA design and DMA record plan which is to be maintained by all the utilities in order to understand the characteristics of DMA.

Figure A: DMA Concept.

DMA Design

The Design of the DMA has been carried out using a set of criteria to create DMA design that has then been tested both in the field and by using a network model. However, the results will be further validated as the network model is calibrated and work progresses.

Criteria of DMA Selection

- Optimum number of connections in the DMA varies from 1,000 to 2,500 on average. However, based on the actual site conditions and feasibility of hydraulic segregation the number of connections in any particular DMA may vary from 500 to 4,000 connections.
- Minimum number of valves that need to be closed to isolate the DMA
- Optimum number of flow meters to measure inflows and outflows (the fewer meters required, the lower the establishment costs)
- Ground-level variations and thus pressures within the DMA (the flatter the area is more stable the pressures and easier to establish the pressure controls)
- Easily visible topographic features that can serve as boundaries for the DMA, such as canals, drainage channels, railroads, highways, etc.

To divide a large open system into a series of DMAs, it is essential to close valves to isolate a certain area and install flow meters. This process may affect the system pressures, both within that particular DMA as well as its surrounding areas. Therefore, while designing the DMA it is necessary to ensure that the water supply to customers is not compromised in terms of pressure and supply hours^{7,8,9}.

Network Modelling for DMA

Network model is a mathematical approximation of the behavior of the water supply network. It contains information about,

- Physical location
- Flows
- Pressures
- Demands

The Following data shall be collected each DMA wise as mentioned below,

- DMA Summary, which comprises location of DMA, details of nearest DMA, details of service stations, details of main source
- Property counts of the DMA
- Ground elevation details
- Pipeline diameter and length
- Pipeline Material & Age
- Metered Consumers Categories
- Details of Large & Bulk consumers
- Boundary & Internal valve details
- Inlet to the DMA – Flow measuring points & details
- Details of public stand post if any
- Water supply Demand & Future Demand (in case required)
- Consideration of Peak factor based on future demand
- Flow pattern of the DMA (internal valve operation)
- Service to the customer

After Collection of relevant data the DMA design can be carried out using network modelling as illustrated in figure B

Figure B: DMA Network Model.

Activities Involved in Network Modelling

- Design criteria based on guidelines of CPHEEO manual.
- Collection of field data as mentioned above.
- Initial level of water balance area wise by conducting temporary flow measurements along DMA inlets.
- Calculate the base demand from the consumption data of the consumers
- Building the model and validate it for the existing water supply network.
- Running the base as well as child scenarios in steady state and extended period simulation mode to check the adequacy of system for continuous water supply.
- Calibrate the base model based on the flow and pressure data from the field and run the model.
- The scenarios for various stages shall include existing water supply network, proposed water supply network, peak demand supply, rehabilitation plan, calibration for existing networks, DMA zone.
- Allocating the demands to the nearest nodes using consumer data for present stage and allocating the demand by creating Thiessen polygon and using load builder with any appropriate method for design stages.
- Checking the demand and supply of the zone including determining the capacity of reservoir using mass curve and rezoning of operational zones.
- Checking the status of reservoir with respect to inflow and outflow of water tanks and representing it graphically for 24 hours.

- Setting the Flow Control Valves (FCV) for required inflow to the tank, plotting the various profiles with respect to ground level and Hydraulic Grade Level (HGL).
- Provide valve details based on ground reality
- Calibration of hydraulic model to simulate with ground reality shall be done for existing network using field data as per actual observation obtained during water audit.
- Demarcation of various district meter areas (DMAS) showing suitable location of district bulk meter and size of bulk meter.
- Preparing the rehabilitation plan by necessary replacement of pipe and valve etc. using the hydraulic model, running the model.
- Preparation of report, drawing and printing the same in presentation form. Detailed immediate recommendation to rectify the existing water supply network and suggestion to convert the intermittent water supply to continuous water supply stage wise also shall be included in report.

Calibration of Model

Accurate model= Good decisions.

Next Decision - from model identify:

- Critical Pressure Point (CPP) the point of lowest pressure.
- Average Zone Pressure Point (AZP) - a point which is representative of the average pressure in the DMA.
- Inlet Pressure to understand pressure variations into the DMA
- Calibrate network against current flow/pressure data

Figure C: Calibration of Model.

CONCLUSIONS

The activities of Network modelling of District metered area design for the existing system is entirely differs from the green field project. This modelling of DMA initially network model to be carried out based on actual consumption in the area then the model to be calibrated along with flow and pressure data collected from the field^{10,11,12}. Once the model become nearby approximation of the actual field then the future projection will be carried out for improvement of the water supply scheme. As mentioned above formation of DMA along the water supply scheme is an essential activity for NRW reduction activities.

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