

IMPLEMENTATION OF AMR FOR REVENUE PROTECTION

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1. INTRODUCTION

NDPL is the first one in India to implement AMR on such a large scale. We are having all HT CT meters and all LT CT meters being read with AMR. This technology is used by NDPL to streamline billing process and theft detection.

2. BILLING PROCESS

Conventional method of billing was to send a meter reader to the site where meter is installed and then that meter reader use to note the reading of the meter in a notebook / sheet provided to him by utility. He use to bring this reading to commercial office and bills were generated after punching the reading in Computer / manual bills were calculated. After that came the era when meter reader use to go with a Hand Held Device(HHT). He use to punch the reading in that HHT against the connection number and the this HHT was brought to commercial office and connected to computer and upload the reading in the system. This decreased the time of punching reading one by one in the system. All the reading were uploaded in a single go. But in this process also there was a chance of mistake as the reading in HHT is punched in by reader so there was manual intervention. This problem was then removed by downloading the data of the meter with Meter Reading Instrument (MRI). In this case an MRI is to be connected to meter and then the data stored in the memory of meter gets downloaded in MRI. This MRI is then connected to computer in commercial office and the data is transferred to base computer. So the problem of manual intervention was removed but a new problem came in picture. In case of MRI reading of meter took more time then as compared to conventional method. So man power need to be increased to complete billing cycle in stipulated time. Secondly another problem in this case was meter box if sealed need to be opened every time. This second problem was more serious as any one can tamper with meter. So the solution was provide by

AMR(Automated Meter Reading). In this process MODEM is connected with Meter through Optical Port / RS 232 port. Modem used in India are GSM modems. Another modem need to be connected to computer in which Base Computer Software (BCS) is loaded. Every meter is having its own protocol to which it responds so for every make of meter different BCS is required and it is provided by meter manufacturing company. This BCS is compatible with only their make of meter and cannot be used to read any other meters. So if any utility is having meter of more than one make they need to load BCS for all the make of meter. Then Schedulers for reading are to be prepared in BCS and then they are run on computer. In schedulers the GSM no which is to be dialed is fed. When scheduler runs it dials that no and sends a hand shaking commands. The meter on the other end recognizes these commands and if it is of the same make and handshaking is done successfully. If the command is send to some other make of meter handshaking is not done. In this case communicate stops there. Once handshaking is done then BCS send a set of command to meter in which is encrypted the choice as what type of data is required. Meter recognizes this command and forwards the required data to the BCS. This data when received by BCS is saved in a particular file at some predefined location. The name of the file is also predefined and cannot be altered. So in this manner the data which was to be collected from site by MRI is collected in computer with the help of BCS and lot of time / Manpower is saved. In this way all the manual errors which were associated with the system gets removed. Reading cycle time is also removed and the revenue which use to come after 15-20 days of starting reading flows in just with in 10-12 days. Another advantage of this reading is coffee shop reading is also eliminated. This one of the biggest problems in electricity utilities. Once the data is received in BCS from with AMR then the billing data of the meter is converted to ASCII format and this

format is made compatible with structure of tables present in the billing server. Then this file which is compatible with the billing server is uploaded in billing server / data base. This data is then verified with some checks in the system like consumption with 0 demand etc. If some exception is found it is corrected there and then and once all these checks are made then the data is processed for generating bills. At the last the bills are printed. So in this process no manual intervention is there and all the process is automated or is done without editing any values coming from the meter. These bills are error free and reliable. All the readings are perfect.

3. ANALYSIS

Analysis is one of the biggest weapons in the hand of utilities after this generation of electronic meters has been implemented. Meters have ability to record the electrical parameters of the system in its load survey as well as meter is provided with some intelligence to detect abnormal electrical conditions. All these abnormal electrical conditions are detected by meter and are stored as exception in the memory of meter. Complete data of the meter is can be downloaded and all the exception of the meter can be studied. Then the exception can be verified as if they are because of system condition of they are created by consumer to manipulate the recording in the meter. All the problems can be identified sitting right in the office and then the cases in which there are problem can be visited with a pre defined target as what is the problem rather than the earlier case where the site is visited first then data is downloaded and brought to office and uploaded in Computers and then analysed and after that if there is any problem which was not attended in the first visit is checked by again going to site. Old method was more time consuming and secondly it alerts the consumer also. Along with electrical parameters there consumption is also recorded in the meter and transaction details are also available. All these parameters can be checked. Instantaneous parameters of the meter are the just the finger prints of meter health. Any abnormality in the meter can be checked from the instantaneous parameters of the meter. Phasor diagram clearly representation of connections of

meter. All the reading in the meter can be compared with those logged in the billing system of utility and any exception can be checked. This helps in verifying the reading brought by the readers.

4. EXCEPTIONS

Now the outcomes of the analysis are referred to enforcement wing of the company / SEB. These exceptions can be voltage missing in any one of the phase or current absent in any one of the phase. The exception can be abnormal power factor recorded by the meter. It may be injection of High Voltage / High frequency in the meter to disturb its functioning. Cases have been seen even where there is no power in the meter for days. All these exceptions when detected need be checked from site. Condition of the meter is physically verified and connected load of the meter is noted. Then the load profile of the meter is studied in accordance of load and voltage condition persisting in that area. If some other meter is installed in the same premises which is fed from the same feeder its data is also compared to check the voltage condition of meter under the scanner. Now comparison of the voltage will give an indication if any manipulation in the voltage parameters is done. Then the current in the all the phases is checked and it is compared with load condition. Meter should have recorded the current in all the phases in accordance with the load connected to those phases. If all these conditions are normal then tamper conditions / exceptions recorded by meter are noted and verified with the records of local area staff records. So in this way a complete analysis and verification of the meter is done along with that some normal test of the meter are also performed at site like accuracy check of the meter. One all these parameters are found in normal condition then meter is declared 'OK'. If in any of the meter there is deviation from normal condition then it is verified as if the deviation is because of system it self or consumer has created it and based upon that assessment / theft bill is raised. Now if the deviation is because of system, then that fault if repairable, is attended and normal metering is restored and assessment for the faulty period is raised. But if it is not repairable then the equipment which is faulty is repaired / replaced and normal metering is

restored. If the fault is created by consumer intentionally then the faulty equipment is sealed and the entire meter is unit is replaced. Sealed equipment is used as a proof / evidence of theft. Thus revenue is ensured. So with the help of AMR any meter related problem can be detected and analysed right in Back office and downtime of the problem is also decreased as the problem is located very quickly. Further intelligence can be developed in the systems based on experience that can check and identify the problem as it is created by consumer or it is because of system. So in this way all the erratic cases can be segregated and dealt with without visiting all the sites.

5. CASE STUDIES

Many types of tampers have been detected in meters. Analysis of all these meters shows that consumer is well aware of the technology used in the meters. Some of the cases which have been detected are discussed.

a. Potential Missing: This problem is mainly of CT meters. In this case voltage of one or two phases is not connected to meter and so meter does not record consumption of that phase. Hence meter gets slow. From the analysis of cases found it has been observed this problem mainly occurs from the day of installation of the meter. The reason can be poor workmanship or wrong intention of the consumer and the installing agency. This problem may occur due to unhealthy installation also. If some loose connection is left in potential circuit then slowly it starts carbonizing and finally the connection gets opened. This problem mainly arise where the material of wire whose joint made is different. E.g. if joint of copper and aluminum wire is made then with the passage of time its oxidation takes place and then sparking starts and ultimately joint gets carbonized completely. Hence the problem of missing potential occurs. This problem can be detected easily as the voltage for a particular system is defined and it does not vary much. So any deviation in this parameter is easily located.

b. CT open / CT bypass : This problem also occurs mainly from the day of installation as in the case of potential

missing. Its reasons are almost the same as that of potential missing. But this tamper is preferred by consumer over potential missing as current is dependent on load connected to the system. So some time it is difficult to locate. Another mode of tampering in case of CT Open / CT bypass is by using RF remote. In this type of tampering a relay is placed in the CT circuit of all the phases and it is connected to an RF receiver. This receiver when gets a signal from an RF remote transmitter changes the condition of relay. SO the circuit can be opened and closed with the help of RF remote and in that case the voltage of system will be there but meter will show no current condition. But actually load is running. This is another type of tampering. But in this type of tampering meter need to be opened completely and then all these devices are inserted in its circuit. CT bypass is another was of tampering the meter this will reduce the amount of current measured by the meter for reading and instead of complete noload condition some load will be measured by the system.

c. Abnormal Power Failure : Abnormal power failure is another modes operandy used by consumer. In this type of tampering high voltage and high frequency is applied on the meter and due to this Electro magnetic field meter electronic circuit gets effected and even stops working. Equipments with increased rating are coming in market with a wide range of voltage and frequency. Meter when subjected to such a wide range of voltage and current becomes dead and does not record any thing rather it shows complete power failure. The rating of this device is much higher that what is specified as per BIS for the testing of meter. In some meters same condition comes if some high voltage is fed through neutral of the meter.

d. Reversing of unit / Energy : It has been observed in meters that if they are subjected to High EM fields then their EEPROM gets reinitialized and reading of the meter is set to 0. these meters then again start reading normally and their accuracy also remains the same. Only problem is they get reinitialized and if these meters are not read regularly it may lead to great revenue loss. This phenomena of re initialization of the

reading has been observed in the single phase meters mainly. In CT meters this phenomena leads to recording of power failure in the meter.

e. DC injection : This was one of the biggest problems of the utility. In this type of tamper AC voltage is rectified using a same single phase rectifier and is injected to the neutral of the meter. This DC voltage then when injected in the neutral of the meter disturbs the measurement parameters of the meter. So the meter starts recording some abnormal values of the voltage and leads to malfunctioning of meter. Some meter have a feature of protecting themselves from system fault. In that case meter if detects some abnormally high voltage the it disconnected it self from the system using an internal relay. But this condition gets artificially created in the case of DC injection. So if DC voltage is injected in the meter then meter protection relay remains open all the time an meter will record power failure for that duration but in reality load is running. Some cases have been seen in which high magnitude of DC voltage has completely damaged the meter. In this case tampering of the meter can be easily detected by looking at the profile of voltage. But in some meters when any abnormal signal is detected in the neutral of the meter then only neutral of the meter is disconnected from the system and internal star point of all the voltages is made and an artificial neutral is created. This neutral then acts like actual neutral and measurements are made as per that neutral. In this case there is an advantage as well as disadvantage. The advantage is that measurement of energy goes on with a bit deviation. But the disadvantage is that meter does not record the abnormal value of voltage which would have been created in case of DC injection so no proof of tampering the meter or attempt of tampering the meter is available.

f. CT / PT ration resetting : Cases have been detected in the meter where the CT /PT ratio of the meter is reset to $\frac{1}{5}$ from a predefined value thus making the internal ration of meter as 1 for current. So the reading now which will get recorded will decrease and thus will lead to loss of revenue. These problem can be detected

with the help of AMR by detecting the ratio of the meter from the data and fall in consumption.

So it can be concluded that with the help of AMR it is easy to keep an eye on the consumer. No doubt consumer is making lot of efforts to seal power from the utility system and he is doing a lot of R&D work in the field but even then with the help of Amr an eye can be kept on the consumers and they can be stopped from stealing power.