

3.2 INFORMATION TECHNOLOGY AUDIT OF COMPUTERISATION OF LOW TENSION REVENUE BILLING

HIGHLIGHTS

The software in Hand Held Device was incomplete and the billing software in the regional server was deficient in various billing components like power factor penalty, Kilo Watt Hour penalty, average billing and billing of door lock cases.

(Paragraphs 3.2.11, 3.2.13 to 3.2.22)

Inaccurate master data relating to critical fields and absence of input controls rendered the assessments vulnerable to errors.

(Paragraphs 3.2.26 and 3.2.27)

The deficient software coupled with manual interventions led to scope for errors in assessments of Current Consumption charges. Audit observed discrepancies in the assessments in Chennai (North) region for the period April to December 2006.

(Paragraphs 3.2.29 and 3.2.30)

Weak password controls rendered the data vulnerable to unauthorised modifications.

(Paragraph 3.2.31)

Introduction

3.2.1 The main functions of the Tamil Nadu Electricity Board are to generate, transmit and distribute electricity in the State of Tamil Nadu. One of the major sources of revenue to the Board is from supply of electricity to the Low Tension (LT) consumers. A consumer who avails supply of electricity at a voltage ranging from 250 to 650 volts with a sanctioned load upto 112 KiloWatts (KW¹) is called as a LT consumer. The consumers of LT are broadly classified into six categories *viz*, Domestic (Tariff-I); Street light, Public water supply, recognised educational institutions and temples (Tariff-II); Industry (Tariff-III); Agriculture (Tariff-IV); Commercial (Tariff-V) and Temporary supply (Tariff-VI).

3.2.2 The Board proposed (January 2005) to computerise LT revenue billing in the State covering 615 out of 2,420 section offices under phase-I at a cost of Rs.113.55 crore to be completed by March 2006. The project was, however, completed at a total cost of Rs.52.14 crore due to integration of wireless network into wired network and the computerised billing commenced in April 2006 in 615 section offices.

3.2.3 The main objectives of computerisation are to reduce the errors and mistakes in assessment of the LT services, to provide improved services to the consumers by having a real-time system, to improve productivity in the assessment work and to ensure ready availability of management information.

3.2.4 The computerised system consisted of hand held devices (HHD²) for calculating the current consumption charges (CC charges) on entering of the meter readings by the assessor³, local servers at the section offices, a centralised server at the regional level (Chief Engineer's office), and computers for the various users including the Billing Assistants and Assistant Accounts officer in the revenue branch. The section offices, revenue branch and the regional server are linked through network. The processed data in the HHD is uploaded to the regional server through the local servers. Wherever HHD is not used for assessments, the Billing software installed in the regional server performs the assessment of CC charges on entering of the meter readings directly by the Billing Assistants.

3.2.5 The LT billing system was designed as a web-based application under three-tier architecture. The client tier provides user interface in PHP (Hypertext Preprocessor) which makes request to the middle tier *viz.*, web server. The backend-tier containing the information in Oracle Database Management System is functioning on Linux operating system in the regional server.

3.2.6 The LT billing system contains five modules *viz* (i) assessment module (ii) collection module, (iii) application module, (iv) revenue accounting and

1 A measure of power equal to 1,000 Watts.

2 A small pocket sized computing device.

3 An employee in the Section Office responsible for making assessment of CC charges.

(v) management information system. While the HHD was designed to handle the assessment module, the billing software installed in the regional server was designed to handle all the modules, including the assessments that could not be performed by the HHD.

Audit objectives

3.2.7 The audit objectives framed to evaluate computerisation of the LT revenue billing are:

- * whether appropriate methodology for system development and implementation was adopted.
- * whether the IT controls in place were adequate and effective.
- * whether the business rules as stipulated by the Tamil Nadu Electricity Regulatory Commission and all the billing components have been embedded in the software.
- * whether the computerised system ensured data integrity and security.
- * whether the objectives of computerisation were achieved and
- * whether the prescribed purchase procedures were complied with and the IT infrastructure created was reasonably utilised.

Audit scope and methodology

3.2.8 The IT audit conducted during December 2006 to June 2007 covered examination of the procurement contracts and records related to computerisation at the Board's Headquarters office, selected regional Chief Engineer's offices and in the section offices. Audit analysed data relating to three out of nine regions viz., Chennai (North), Chennai (South) and Coimbatore. The data analysis was made using Structured Query Language (SQL)⁴ on the database for the period April 2006 to February 2007 provided to Audit. The audit methodology included:

- * issue of questionnaire,
- * discussions with the executives, and
- * visit to the data centre for observing the physical and environmental security practices adopted by the Board.

Audit findings

The significant audit findings are discussed in the succeeding paragraphs.

General controls

Lack of IT policy and documentation

3.2.9 The Board is yet to formulate and document a formal IT policy defining the long term/medium term IT strategy incorporating the time frame,

4 An interactive programming language to create, maintain, and query relational databases.

key performance indicators and cost benefit analysis of the various applications and their integration. There was no comprehensive documentation for testing and acceptance of the software. The Board accepted (July 2007) absence of IT policy and expressed that the administrative approvals given from time to time were to be treated as the Board's policy. The Board's view is not acceptable as administrative approvals were specific to the scheme and its implementation and did not contain short-term and long-term goals and other essential components of computerisation like strategic plan. The Board also stated (July 2007) that documentation for software would be devised appropriately.

Inadequate data back-up procedures

3.2.10 The Board did not have Business Continuity and Disaster Recovery Plan⁵ to ensure uninterrupted continuity of business in the event of any temporary or permanent disaster leading to loss of data. Audit observed that a copy of the back-up was not kept off-site to ensure business continuity in case of any catastrophe causing damage to the data. The Board stated (July 2007) that it would provide a backup server to secure data in the regional server.

Deficiencies in the software

3.2.11 The Board placed (January 2006) an order for development of the software for incorporation in the HHD on Signals and Systems (Private) Limited, Chennai at a cost of Rs.1.41 lakh. However, due to failure of the firm to supply the software, the HHD supplier, Analogic Technomatics Private Limited, Hyderabad, who was awarded the contract for supplying 2,600 HHDs at a cost of Rs.1.99 crore, agreed to develop and supply the HHD software also free of cost. Though, the Company supplied (April 2006) the software, it was noticed in audit that it was incomplete as it could not handle the assessments involving door lock cases, meter defective periods, penalty/rebate for power factor, penalty for exceeding the sanctioned load, tariff changes, change of sanctioned load, adjustment of credit/advance CC charges, billing of temporary services and billing based on previous month consumption *etc.*

The above mentioned deficiencies in the HHD software coupled with inadequacy of the billing software housed in the regional server to establish interface with the HHD resulted in poor utilisation of the HHDs for assessments to the extent of only 28.4 *per cent* of the total assessments in Coimbatore region and 20.9 *per cent* in Chennai (North) region during April 2006 to February 2007. Therefore, bulk of the assessments were carried out through the billing software in the regional server leading to scope for errors in data entry. While the software in the HHD was not a complete and error free one, the billing software embedded in the regional server also suffered from a number of deficiencies as discussed in paragraphs 3.2.13 to 3.2.22.

The Board stated (July 2007) that the usage of HHD had improved to 85 *per cent* since March 2007 as most of the deficiencies and defects were rectified and attributed the earlier poor utilisation of HHD to the teething problems

⁵ The plan of an organisation to continue to function even after a disastrous event.

encountered in the initial stages of the project. Audit, however, ascertained that while the utilisation of the HHD for the last seven months ending September 2007 was at 80 *per cent*, majority of the assessments involving door lock, meter defects, disconnected services *etc.*, could not be handled through the device. More importantly, the device was utilised to the extent of 50 *per cent* only for assessing the industrial services as it was not capable of assessing such services which involved a number of billing components.

3.2.12 Audit observed certain program deficiencies including deficiency in mapping of the business rule in the billing software as discussed below:-

Rounding-off errors

3.2.13 Power factor, the ratio of the real power to apparent power has to be calculated to three decimal points and rounded off to two decimals for billing purpose. Incentive is allowed to the consumers, who maintain the power factor in excess of 0.90. Data analysis in Chennai (North) and Chennai (South) regions for the period April 2006 to February 2007 indicated that in 816 assessments and 1,210 assessments, respectively, the power factor in excess of 0.90 was not rounded off to the two decimal places for billing purpose resulting in payment of excess incentive of Rs.0.72 lakh and Rs.0.82 lakh respectively. Similarly, wherever the power factor was below 0.85, it was not rounded off to two decimals resulting in short levy of penalty amounting to Rs.0.60 lakh and Rs.0.24 lakh respectively in respect of 432 assessments and 453 assessments in these two regions.

3.2.14 Audit scrutiny in Chennai (North) region indicated that in respect of 1,70,866 assessments under the non-CT category (services with a sanctioned load upto 75 Horse Power), the last digit of the units consumed was not rounded off to multiple of ten units due to absence of provision in the software.

Incorrect levy of CC charges for the door lock cases

3.2.15 When the meter installed in the consumer's premises was inaccessible for meter reading, it was called a door lock case. Assessment of CC charges for such cases has to be made provisionally based on the consumption during the previous assessment period. An analysis of the door lock assessments (first door lock) in Chennai (North) and Chennai (South) regions indicated that in 1,402 and 2,086 assessments, provisional assessments were made at Rs.23.11 lakh and Rs.17.89 lakh as against the correct assessment of Rs.36.73 lakh and Rs.35.66 lakh respectively indicating short billing of provisional assessments by Rs.31.39 lakh. The program did not compute the assessments with reference to the previous assessments as per the business rule.

Error in computation of the belated payment surcharge

3.2.16 The consumers paying the CC charges within 15 days after the prescribed due date for payment had to pay Belated Payment Surcharge (BPSC) at the rate of 1.5 *per cent* per month for a minimum period of 15 days. Audit noticed that due to incorrect mapping of this business rule, BPSC

charges from 5,297 domestic consumers in Chennai (North) region for six months period during 2006-07 were wrongly calculated by charging for the whole month instead of limiting to 15 days resulting in excess levy of Rs.0.34 lakh.

3.2.17 Also, the consumers, who defaulted payment of electricity charges within the due dates, were also liable to pay the reconnection charges along with BPSC. A review of the delayed payments collected in Chennai (North) region and Chennai (South) region indicated that the total amount collected was lower by Rs.0.06 lakh. This indicated that the program did not ensure correctness of the total dues.

Error in billing on 'bi-monthly minimum' basis for industrial services

3.2.18 For industrial services, the CC charges based on the units consumed or bi-monthly minimum charges at Rs.80 per KW of the sanctioned load or part thereof whichever higher has to be levied along with power factor penalty, if any. Data analysis in Chennai (North) region for the period April 2006 to February 2007 indicated that the power factor penalty of Rs.0.26 lakh was not levied in 94 assessments made on bi-monthly minimum basis. While assessing the services on bi-monthly minimum basis, the program computed the power factor incentive payable to the consumers, but it did not recognise the power factor penalty, if any, receivable from the consumers.

Absence of program to calculate Current Consumption Deposit

3.2.19 The consumer availing three phase service connection has to pay Current Consumption Deposit (CCD) at the rate of Rs.600 per KW or part thereof of the sanctioned load. Data analysis of the new services having three phase connections effected during April 2006 to April 2007 in Chennai (North) region indicated that in 15 cases, in the absence of a provision to calculate the CCD in the system, the same was manually computed on the sanctioned load without rounding off the fractions to the next whole number resulting in short collection of Rs.19,580.

Non-levy of penalty for exceeding the sanctioned load (KW penalty)

3.2.20 In the case of service connections of industrial, commercial and street light, public water supply, recognised educational institutions and temples having a sanctioned load exceeding 25 HP, when the recorded demand exceeds the sanctioned load, penalty at the prescribed rates was recoverable for the excess demand. Due to inadequate mapping of the relevant business rules manual intervention was resorted to. A test check in two section offices in Coimbatore region revealed that in five cases, where the actual demand exceeded the sanctioned demand, the penalty amounting to Rs.0.14 lakh was either not levied or incorrectly levied.

Non-closure of consumer ledgers

3.2.21 As the computer system did not provide for automatic closing of the consumer ledgers closing in the system was activated manually. A review of

such closing of the ledgers in Chennai (North) region for the period April 2006 to March 2007 revealed that only in 82 out of 22,566 occasions, the ledgers were closed. In the absence of automatic closing of the ledgers by the system and failure to do the activated process regularly, the dues from the consumers could not be determined in time. In addition, there was mismatch between the list of consumers who failed to pay the CC charges in time (*i.e.*, defaulters) and the list of defaulters as per the consumer ledger closing.

Deficiencies in the program in preparation of consumer's balance

3.2.22 Audit observed the following deficiencies in the program in arriving at the consumer balances:-

- * The system should match CC charges collected from the consumers to the relevant bi-monthly assessments so that the demands and collections were duly matched. Audit observed that the program did not segregate the arrears billing cycle wise and did not match the collections from defaulters against the appropriate dues in chronological order instead showed the collections against the latest bill. For e.g., in one case, the consumer failed to pay the dues relating to March 2007 (Rs.6,062) and May 2007 (Rs.2,278). When the consumer paid the dues of March 2007 in June 2007, the same was appropriated against the dues of May 2007 (Rs.2,278) and thus the consumer ledger showed a credit balance of Rs.3,784. As a result the unmatched arrears continued to remain as unpaid in the database.
- * Audit observed that the program did not consider the credit available against one consumer and instead included him in the defaulter's list for the month of May 2007.

The Board agreed (July 2007) to review the above issues to make necessary changes in the program.

Change management controls

A general review of the change management controls indicated the following:-

3.2.23 Since introduction of the software, for the changes made in the program, a formal procedure for receiving change requests from the users, operational staff, and developers and for approving the changes was not followed. The details of amendments made indicating the reasons for changes, nature of changes, details of testing conducted, and date of approval by the competent authority were not documented and maintained.

3.2.24 Audit observed that the necessary change in the program for free supply of 500 units of power to the power loom service connections with effect from 1 August 2006 was not made and the old business rule to charge at one rupee per unit for 500 units was continued (March 2007). A review of the bi-monthly assessments for the period October 2006 to March 2007 involving consumption of units up to 500 units by the power loom service connections in Chennai (North) region indicated that:

- * the program worked out the CC charges at the old rate of rupee one per unit.
- * fixed charges at Rs.60 itself was not collected in 24 cases, and
- * bi-monthly minimum charges at Rs.120 and fixed charges at Rs.60 were levied and collected in 34 cases instead of billing the fixed charges alone in such cases.

Timely modification of the program could have avoided the above.

Application controls

Input controls

3.2.25 Input controls ensure that the data received for processing is authentic, complete, has not been previously processed, accurate and properly authorised and is entered accurately and without duplication.

3.2.26 The major deficiencies observed by Audit in the maintenance of master data in Chennai (North) region are given below:-

- * Wrong entries were observed in critical fields like sanctioned load and names of the consumers. The sanctioned load in KW of 33,279 consumers was wrongly entered without decimal places and the names of 6,520 consumers were entered as ‘*, =, AAA, aa, XX and other single characters making the electronic record incomplete and illogical.
- * The master data in respect of 7,38,442 customers did not have the date of service connection. Similarly, it did not contain the customer number for 16,096 services as on 30 April 2007 who were sanctioned new service connections/additional load.
- * In respect of 9,22,368 services, the serial number of meters was indicated as ‘1’ and for the balance 26,842 services, some arbitrary numbers were indicated making the information unusable in case of theft/unauthorised change of meters *etc.*
- * A review of the LT database in Chennai (South) region for the period April 2006 to March 2007 revealed that though the tariff category in respect of 11,475 assessments was changed from commercial to domestic tariff as per the consumers’ request and the billing was correctly made by manual process with reference to the domestic tariff, the change of tariff was not effected in the master database. It indicated the state of inconsistency between manual and computer data. As the change of tariff from commercial to domestic was not simultaneously updated in the computer system during the year 2006-07, the consumption as per the database was lower by 34.23 lakh units under domestic tariff in Chennai (South) region and 17.07 lakh units in Chennai (North) region. Such non-updation of master data as per periodical change in tariff has the risk of non-claiming of subsidy from the Government in proportion to the actual units consumed.

In the above mentioned instances though the assessments were corrected by manual interventions, the master data was not updated, which would lead to wrong MIS. The Board agreed (July 2007) to take action to correct the wrong values in the master data of the LT billing.

3.2.27 In the following cases Audit observed absence of input controls in the transaction data:-

- * The tariff category in 34 and 198 assessments in Chennai (North) region and Chennai (South) region respectively was indicated as 'Null'.
- * In Chennai (North) region, a review of meter reading of consumption exceeding 50,000 units in 2007 indicated incorrect consumption ranging from 50,960 to 10,15,100 units in 73 assessments. It indicated the presence of error in data entry/data transmission. Though the assessment of the CC charges was manually corrected based on the correct quantum of consumption, the consumption of units was not corrected in the database to ensure data integrity in the electronic records.
- * When the assessments were modified, the original records got removed and stored separately in the database. Audit observed that out of 55,618 assessments which were modified in Chennai (North) region, 5,753 assessments did not have proper remarks and contained single characters, special characters and combination of characters leading to lack of audit trail. In 24,642 cases, the reasons for the modifications were recorded as "wrong entry" without mentioning the nature of wrong entry. Had a systematic supervisory review been in place and conducted, incomplete input could have been avoided.
- * In Chennai (North) region, nine applications for single phase connections were wrongly indicated as three phase connections, though the charges/deposits applicable for single phase connections were collected.
- * Meaningless values like null, zero, 1, 2, 12, 85, 3200, and 5006 were found against the year in which the receipt for payments was issued by the Inspector of Assessment.

The Board accepted (July 2007) the audit observations and agreed to make necessary corrections in the program to provide validation controls.

Validation controls

3.2.28 Audit observed absence of validation controls in the following cases:

- * In respect of 1,232 services of industrial consumers, though the sanctioned load exceeded 4 KW and they were to be treated as three phase connections, the database accepted them as single phase connections indicating poor input validation controls.

- * Certain industrial and commercial service connections may require welding set in them. While service connections with welding sets were not required/availed by the consumers of domestic category, in respect of 40 domestic services, the master data indicated that welding sets were installed in them. Though the billing was correctly done by manual interventions, the master data was not corrected.
- * The fixed charges as per database in respect of 13 assessments and six assessments in Chennai (North) and Chennai (South) regions respectively contained unreasonable amounts exceeding Rs.1,000 as against the maximum possible fixed charge of Rs.60. The billing software did not validate the entry in this regard.

The Board accepted (July 2007) the audit observations and agreed to make necessary corrections in the program to provide validation controls.

Manual intervention and impact

3.2.29 The deficiencies in the HHD software and inadequacy of the billing software to establish interface with HHD *etc.*, led to large scale manual assessments and entry of the data in the system manually. Even in such cases of entry of manual assessment data in the system, the latter performs assessments of CC charges and thus for each such transaction there are two figures in the database namely the system computed amount and manually assessed amount. To ensure correctness of the assessments, the system provides for reconciliation. However, the discrepancies between the two figures was not systematically analysed by the Sections to identify the deficiencies and to rectify them. On this being pointed out, the Board agreed (July 2007) to take action to reconcile such cases.

3.2.30 Audit analysed the assessments pertaining to the period April to December 2006 in Chennai (North) region with a view to ensure the accuracy of assessments and observed discrepancy between the Board's assessments and the assessments as worked out by Audit. The main reasons for discrepancies were:

- * errors in data entry,
- * errors and non-updation of the master data like sanctioned load, tariff classification, and
- * software deficiencies.

Accordingly, five out of eight revenue branches in Chennai (North) region verified the discrepancies partially with respect to commercial and industrial tariff consumers and accepted a short levy of CC charges amounting to Rs.26.54 lakh. Verification in respect of other cases is awaited.

Inadequacy of the HHD software, and under utilisation of HHD, deficiencies in the billing software, errors in the master data, and existence of large scale un-reconciled discrepancies *etc.*, therefore, do not give assurance that the

Board has achieved the objectives of reducing errors and mistakes in assessments and ensuring reliable MIS.

IT security

3.2.31 Protecting the information assets is a critical factor to ensure continued availability of information, data confidentiality and integrity. Audit observed the following weaknesses in security control:

- * Though modifications made in the data relating to customer, services, meters and meter reading were maintained in the database separately, they were not subjected to supervisory review periodically to ensure that the changes were authorised.
- * The database provides for capturing Internet Protocol (IP)⁶ address of the computers for every assessment to identify the computer from which the data was entered. In Chennai (North) region, during the period April to October 2006, 2,91,894 assessments did not contain IP address of the computers for facilitating audit trails in such cases.
- * A review of the database in Chennai (North) region for the period April 2006 to February 2007 indicated that officers who were empowered to add assessment records were also given powers to delete records. Such users deleted 33,190 records during the said period indicating improper and weak authorisation controls.
- * The Board had not implemented comprehensive password control measures for periodical change of the passwords. Audit also observed that passwords were not changed periodically. It was noticed that the passwords of the AAO were shared with other users having lower access control privileges. For example, a review of the information in the database pertaining to 1 February 2007 indicated that 26 different users added 1,300 assessment records in one hour using the AAO user ID. It showed that the transaction authorisation on behalf of AAO was carried out by different users making the AAO accountable for the correctness and genuineness of the entries made indicating serious security concern. This also indicated that the software did not have provision to restrict multiple user login simultaneously.

The Board accepted (July 2007) to monitor change of passwords by the users periodically by reviewing the log maintained in the regional server. After the above being pointed out in audit, detailed instructions were issued by the Board to the field officers to ensure password security *etc.*

Other topics of interest

3.2.32 The contract was placed (January 2006) on Gemini Communications Limited, Chennai at a firm price of Rs.49.22 crore for hardware and related

⁶ The protocol used for routing and carriage of messages across the Internet.

infrastructure including maintenance of leased lines⁷. Audit observed the following points:

- * Subsequent to the award of the contract, at the instance of the Board, Bharat Sanchar Nigam Ltd (BSNL) allowed (May 2006) a discount of 20 *per cent* on the two Mega Bytes Per Second (MBPS) leased lines availed for the LT billing project. The Board, however, did not ask the contractor to pass on the benefit of reduction in lease charges. The discount accrued at the current rate of lease charges in respect of five regions (Coimbatore, Trichy, Tirunelveli, Erode and Villupuram) alone worked out to Rs.46.18 lakh for the entire contract period of five years. The Board replied (July 2007) that the intricacies of discount had not been anticipated and stated that the same aspect would be considered in the future purchase orders. The Board's failure to get refund allowed by BSNL specific to the LT billing project resulted in potential loss of Rs.46.18 lakh.
- * A comparison of the rates quoted by the said firm for 23 items revealed wide variations for three items *viz.*, Storage Area Network switches, Printer and Ethernet switches between the rates quoted in Chennai (North) and Chennai (South) Regions. Though the contracts were finalised during the same time and the purchase orders were awarded to the single firm, the Board failed to negotiate and fix the rates at the lowest quoted rates, leading to an extra expenditure amounting to Rs.8.55 lakh. The Board stated (July 2007) that the lowest tender was selected based on the total contract value and attributed the differences in the quoted price from region to region to the pattern of expenditure to be incurred by the tenderer. The reply is not tenable as the nature of hardware items was one and same and the Board did not take into account the lowest rate quoted in a region.

Conclusion

The implementation of the project with incomplete software and absence of thorough testing indicated significant departure from the standard system development methodology at each stage of the project. Major deficiencies were observed in entering master data and changes thereto. Change in business rule was also not updated. Wrong data entry coupled with inadequate input controls in the system, inadequacy of the software and error in the software, *etc.*, have led to large-scale manual interventions, disregard to the concept of computerisation. It resulted in differences between the Board's assessments and the assessments made by Audit. Security policies were not clearly defined and strict enforcement of the same were not ensured. Data back-up procedures for the main server as well as local server were not standardised.

⁷ A telephone line rented for exclusive use by an organisation.

Recommendations

- * **The Board should rectify the deficiencies in the software of the hand held device as well as billing software so that the computerisation under Phase-II does not suffer from the software related problems.**
- * **The deficiencies in the master data should be set right so that the developed software would generate the desired results as per the business rule.**
- * **In the light of deficiencies observed in the software and implementation and un-reconciled discrepancies in assessments pointed in audit, the Board may consider reviewing the assessments already made in all the regions.**
- * **The documentation relating to program, amendments to the program and modification of assessments *etc.*, should be systematically maintained and reviewed.**
- * **The IT policy including IT Security should be clearly laid down and strictly enforced.**

The matter was referred to the Government in August 2007; and their reply is awaited (September 2007).