STRATEGY AND PLANNING FOR IMPROVING DISTRIBUTION AUTOMATION ASSET PERFORMANCE

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ABSTRACT
Alexandria Electricity Distribution Company (AEDC) is a government-owned utility serving Alexandria Governorate with electrical power supply through 20 & 11 KV Medium Voltage (MV) network.

Network automation has been applied as Distribution Management System (DMS) since 1997. The standard life cycle for automation equipment (Operator workplaces, SCADA servers and Front-ends) is about 5 to 7 years.

According to the Egyptian standardized accounting system, the annual rate of depreciation for DMS assets is 10% which means that, the life cycle has to be 10 years.

AEDC has considered a strategy to improve DMS assets performance by increasing its life time. The goal of this strategy is to keep the system running as long as possible in good condition without loosing any of its functions and covering all future expansions in MV switchgear and new extensions for MV network to be under automation with no need to upgrade the system.

This paper shows the details of this plan and its results.

INTRODUCTION
AEDC has more than 1.953 million customers. The maximum distributed load is 1898 MW with annual rate of increase about 4.3%. The size of sold energy is more than 7.793*10^6 MWHr [2007/2008].

For improving reliability of electrical power to cover the growth of loads and extension of occupied area for Alexandria Governorate, many projects were applied to add new network elements as Substations, Distributors, Medium & Low Voltage cables and overhead lines, distribution transformers and kiosks. In addition, another plan was applied for renewal of many parts of the network to get better performance.

Network automation is required to get better results after network modification and to make use of this investment. The project of DMS was started in 1995 and put in service in 1997.

DMS consists of three Distribution Control Centers (DCCs) and Supervisory Control Center (SCC). Each DCC controls separate geographical area with no overlapping for decision responsibility. In addition, it serves as a tool for optimal planning which results in economical operation and control. DMS would also be beneficial for quicker service restoration in case of fault, reduction in manpower ... etc., contributing to healthy system development.

Additionally, Supervisory Control Center (SCC) provides for overall monitoring, without control, of the entire Alexandria electrical network. It has access to real-time data and display for all the three DCCs areas. It also provides for reporting capabilities that merge data from all DCCs.

DMS is controlling & monitoring 25 Substations (S/Ss), 106 Distributors (DPs) through a Remote Terminal Unit (RTU) in each S/S or DP and 200 kiosks (as a pilot project for kiosk's automation).

AEDC STRATEGY TO IMPROVE DMS ASSET:
AEDC considered a strategy to keep DMS system's in good condition and increase its life time. The target of this strategy is to cover at least ten years as working period with no major faults or weak performance causing a need for upgrade the system. The goal of this strategy is to keep the system running as long as possible in good condition without loosing any of its functions and covering all future expansions in MV switchgear and new extensions for MV network to be under automation with no need to upgrade the system.

There are three basic directions for this strategy. Figure (1) shows these directions.

1- EQUIPMENT AND SPARES:

1-1-Size of the system:
There was a detailed study to expect the future expansion in MV distribution grid's substations and distributors and any switchgear extensions for next 10 years. The result of this study determined the required and suitable size of the SCADA system. So, AEDC has
mentioned in the specification of the project that, the number of system points (digital, analogue and calculated) is equal to that size plus 10% more. So, there is no need for upgrading the system due to unexpected growth of the system size.

1-2- Determination of RTUs Quantity:

This study gives an accurate expectation for the required spare Remote Terminal Units (RTUs) for future outstation locations' extended switchgear. So, the total number of project's RTUs is determined. Part of them was installed and the rest has used for future expansion.

<table>
<thead>
<tr>
<th>Outstation list in the beginning of the project</th>
<th>No. of Substations</th>
<th>No. of Distributors</th>
<th>No. on Kiosks</th>
</tr>
</thead>
<tbody>
<tr>
<td>21</td>
<td>94</td>
<td>200</td>
<td></td>
</tr>
</tbody>
</table>

Table (1) – List of MV Outstations in the beginning of the project

| Expansion | 3 | 14 | 0 |
| Extension | 4 | 12 | 0 |
| Replacement | 4  | 12 | 0 |

Table (2) – List of additional MV Outstations added to the system after starting the project and till end of 2008

1-3- Spare Parts Selection:

The required experience for spares selection has been obtained from the project's consultant and from the rate of failure of equipment during grantee period of the project.

So, AEDC has selected and stored the necessary group of spares according to user experience.

Good selection of spare parts covers all requirements which are helping for repairing the unexpected failures of any component from DCCs and/or SCC equipments.

1-4- Repairing Technique for the Faulty Cards:

Instead of sending the faulty cards aboard to the manufacturer for repairing and facing a lot of difficulties like transport, shipping, customs and delay for receiving the repaired cards, AEDC has its system for card repairing. This system depends on a well trained and experienced team and an intelligent unit for testing and detecting faults of faulty cards and check functionality of them after repairing. This policy helped for repairing more than 800 cards during the period from the beginning of the project till now. The cost of repairing by this policy is very low comparing with the normal method of repairing by the manufacturer.

1-5- Decreasing Rate of Failure of Cards:

This could be done by making a study for each repeated faults for the same type of cards to detect the cause of failure and take an action to stop it.

This method gives good results and the rate of failure of cards decreased and the working performance for RTU's cards is improved.

2- WORKING TEAMS:

The real support for the process of improving assets performance is the working team.

For each center, there is a structure for the management of the center and working groups. Figure (2) shows this structure. Noting that, there is only one central repairing cards laboratory for the project. Its location is in Middle Distribution Control Center (MDCC).

![Figure (2) - Block diagram for DMS working team structure](image)

2-1- Training for Working Team:

Good training program in each field of application has applied for a selected group from the first generation of working team according to the project operation and maintenance documentations in the manufacturer's training laboratories.

The second generation of working team has got their training program at sight. They have almost the same knowledge and experience of the main one.

One of the most valuable method for training and getting experience is “How to Do” instruction book. This book was created by experienced and well trained team. It has a summary for a definite process “software or hardware” from project documentation and rewriting it in clear steps to help those new working staff to do the required job in easy and safe way without delaying.

Another successful method for training is "Fault Clearance Report" file. This file contains case by case reports explaining a fault condition and the reaction to clear that fault. Each report was signed by the authorized person.
who cleared the fault to be a reference in case of any required explanations or question. In case of repeated fault any one of the responsible staff can apply the same steps to clear the fault very quickly and in good way.

2-2- Experience of Installation Works:

Maintenance team has got the experience of installation works in master station and outstation locations by working as subcontractor to do different types of installation works in the beginning of the project and under supervision of project’s contractor. This experience helped the maintenance team for doing mechanical and electrical installation for future expansions for existing outstation sites and for new extension for medium voltage sites (Distributors and/or substations) with no need for help or support from main contractor of the project.

2-3- Moral & Material support for working team:

For supporting the system continuously with a good team of responsible staff in each field of application, moral and material supporting facilities are given for the working team. These special advantages make a good reason for the working team to stay in Control Department and work harder to keep the system running in good condition as long as possible.

3- SUPPORTING THE SYSTEM:

According to continues modifications and appearing of new generation for SCADA systems, many projects can take the decision for upgrading its system to make use of new advantages of new software.

To keep the available software running for long time without upgrading it and get most of advantages of new generation software, many steps have been taken for supporting the available system and make it very closed to the new ones. Here, there are some of the major supporting actions which are applied to SCADA system of AEDC:

3-1-Creating a backup database storage system:

In case of major faults for main system and without a backup database storage set, it could be very big problem due to loosing the data. So, AEDC hardware maintenance team creates a simple and low cost database storage system by using spare hard discs to store periodically the renewed database of the MV network.

Updating the stored information has been done continuously and regularly by database engineer. These spare discs have been kept in safe and secure place for a time of need.

3-2- Increasing the efficiency of the system:

According to the new versions of SCADA software, many functions and new facilities have been added to get better and easier user friendly version. AEDC software team started to support the system and increase its functionality to get better efficiency by adding many scripts and special reporting forms files as required enriching the system according to the needs of operation and control engineers.

New software programs for power applications are added to get valuable results. These results give a lot of information in study mode helping the decision maker to take better action for optimizing maintenance and improving operation of MV network.

After applying these new additions to the available SCADA system, it became more reliable and supplying the working team with more information through valuable reporting files.

There was a published paper in CIRED 2007 conference for the author explaining in details a local made application software which has been applied to the system for optimizing maintenance and improving operation of distribution network, creating a history for MV cables and distribution kiosks and giving results for some measurements for power quality indices.

3-3- Finding unusual solution for usual Problems:

Because of continuous modification for SCADA software systems and new generation of hardware components, servers and communication methods, the available SCADA system for AEDC became an old system with time. A big and continues effort has been done to renew the system hardware equipment and find simple matching methods to replace partially parts from the available hardware which create a problem due to its faulty operation and has no spares or its production became obsolete by new products. The new products are available in the market but can not be used as replacement for the faulty parts directly. Maintenance time succeeded to use these new products as a part of the available system with no problems by using a suitable interface connection.

An example for hardware replacement is the optical drives which record the database changes and historical event. A new CD read/write devices became available in low price in the market. AEDC used these devices as replacement for the optical drives after connecting a normal Personal Computer (PC) as a terminal to the system through FTP (File Transfer Protocol) program to connect Windows operating system of the PC to UNIX operating system of SCADA servers.

COST OVER THE LIFE CYCLE:

The initial cost of the project contained the cost of training for a selected group of engineers in different branches (control, system engineering, maintenance for outstations and master station, maintenance for electronic cards, maintenance of communication system, software maintenance, power applications studies and database building…), the cost of spare RTUs and the cost of "Intelligent Unit" for detecting the faults and testing the
faulty electronic cards after repairing. The running cost of the project covers operation and maintenance for all four centers and repairing cards laboratory disposable materials and first level components of defected cards.

Cost of some additional spares like hard discs for creating database storage system, memory cards for servers, and mechanical installation equipment and electronic cards for extension works in some substations or distributors has a small budget.

The cost of these spares, equipment and the additional renewal and adoption works though the life cycle of the project till the moment reached about 4% from the project's cost. The cost of installations of new outstation locations and adding them to be part of the system is included too.

There are some spares available same as spare RTUs as strategic supporting equipment for the project for more than next five years according to the rate of failure for some of hardware equipment of the project and the expected required additional works.

CONCLUSION

The results show that DMS is working in normal condition and has its all available functions since 1997.

DMS has a size of more than 125% of the original size in the beginning of the project due to extensions and expansions of MV network. All new outstations are included in the system one by one and on time of MV sites installation.

DMS is covering not only all new MV network switchgears to be under control and supervision but also the future ones for at least next five years.

There is a big effort to keep the quality of information under all possible single hardware and/or software failures by using redundancy and fault tolerance technique without affecting the system performance and keeping it in the highest level of accuracy and availability under the same level of security.

The system is covered by a supervision and maintenance programs to insure about 99.98% system availability with no major problem causing failover of the system as per daily & monthly reporting records.

REFERENCES

Documents:

Published researches:

Books:

AUTHOR:

MOHAMED KHALED EL-SAYED:

He was born in Alexandria, Egypt in Aug. 17, 1949. He graduated from Faculty of Engineering Alexandria Univ. in 1972. Khaled has a Master degree from Alex Univ. in 1978. He has many published papers in many conferences in the field of control systems.

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